DOCUMENT RESUME

ED 425 698		IR 018 956
TITLE	Moving beyond Planning to Technology Implementation. Resource Manual. A Portfolio of Processes.	
INSTITUTION	Mid-Continent Regional Educational Lab., Aurora, CO.	
SPONS AGENCY	Office of Educational Research and Improvement (ED), Washington, DC.	
PUB DATE	1998-00-00	
NOTE	313p.; This document is comprised largely of pages photocopied from other documents, books, and journal articles--some figures, illustrations, and text may, therefore, reproduce poorly.	
CONTRACT	RJ96006101	
PUB TYPE	Reports - Descriptive (141) -- Guides - Non-Classroom (055)	
EDRS PRICE	MF01/PC13 Plus Postage.	
DESCRIPTORS	Computer Assisted Instruction; Computer Managed Instruction; Computer Networks; *Computer Uses in Education; *Educational Technology; Elementary Secondary Education; Information Literacy; *Information Technology; Integrated Learning Systems; Microcomputers; Professional Development; *Program Implementation; Strategic Planning	

ABSTRACT

The goal of this technology implementation workshop is to provide education leaders with frameworks, models, and processes for decision making in relation to technology implementation issues. The workshop components are based on a systems view of implementation comprised of Human Capacity Building, Technical Infrastructure, Organizational Structures and Support, and Connections to Teaching and Learning. This participant manual will serve as a portfolio for individuals to experience and collect frameworks, processes, and strategies that can be utilized in their respective education systems. Section 1: contains 11 articles on classroom and system technology. Section 2: contains seven articles on organizational structures and support. Section 3: contains articles on human infrastructure, including rubrics for information literacy, teacher knowledge base standards, and professional development. Section 4: contains six articles on planning and implementing the technical infrastructure. Section 5: contains information on new educational software. (DLS)

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Moving Beyond Planning to Technology Implementation

Resource Manual

A Portfolio of Processes

Moving Beyond Planning towards Technology Implementation

Workshop Goal
The overall goal of this workshop is to provide education leaders with frameworks, models, and processes for decisionmaking in relation to technology implementation issues. The workshop components are based on a systems view of implementation comprised of: 1) Human Capacity Building, 2) Technical Infrastructure, 3) Organizational Structures and Support, and 4) Connections to Teaching and Learning.

Guiding Questions
The following questions guide the workshop activities:

- *What content and processes distinguish successful technology implementation?
- *What are the critical elements of dynamic, technology infused professional development models or approaches?
- *What models and processes of organizational structure and support best facilitate implementing technology with a vision of open, networked education?
- *What mechanisms will connect classroom level and systems level around a common vision for technology implementation?

The "Work" of the Workshop
The participant manual will serve as a portfolio for individuals to experience and collect frameworks, processes, and strategies that can be utilized in their respective education systems while confronting the issues and challenges of systemic technology implementation.

Workshop Design
The design of the workshop is based on a professional development model developed by the North Central Regional Educational Laboratory (NCREL). It is grounded in their research on adult learning and professional development. The model conceptualizes five dimensions that are developmental and cyclical. The dimensions are: Building a Knowledge Base, Observing Models and Cases, Reflecting on Your Practice, Changing Your Practice, Gaining and Sharing Expertise.

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Chapter 7
Forecasts for Technology in Education

The future of information technology in education is harder to forecast than the general future of information technology. One difficulty is that students and teachers do not control the school budget. As pointed out by Seymour Sarason (1990), they lack power. Another difficulty is that education does not easily change. It is a complex social system. For these reasons, the forecasts or predictions in this section are made with far less confidence than those in the previous chapter.

By and large, the forecasts given in this section are optimistic. They are forecasts of our educational system effectively coping with the changes being wrought by technology. They are forecasts of students getting a better education. Many of the ideas discussed in this section were previously discussed in Moursund (1992).

Eleven General Forecasts
Conclusions and Recommendation

Eleven General Forecasts

This section contains brief discussions of 11 different forecasts for information technology in education. In many ways, these are linked to the goals for information technology in education discussed in Chapter 4. In essence, we are in a situation where the underlying science and technology (see Chapter 6) make it technically possible to achieve the goals listed in Chapter 4. There are a number of underlying driving forces that are contributing to schools adopting some or all of the goals. The commitment of resources, if it continues to grow, will cause the forecasts given in this

chapter to be accurate.

Student Access to Computing Power

The total amount of computing power available to students is growing quite rapidly, and this growth will continue for many years to come. The growth comes from two main sources:

1. The number of microcomputers in schools and in the homes of students is continuing to increase. Eventually the great majority of students will have routine access to a portable microcomputer that they carry between home and school. These portables will have easy-to-use interfaces with more powerful microcomputers that schools will make available to their students.

2. The capabilities of the microcomputers available to students are increasing at a rapid pace.

In the United States at the current time, schools have approximately one microcomputer per eight students. However, there are a number of school sites in which the ratio is approximately one microcomputer per student, or even better. The number of such sites will increase relatively rapidly during the next decade.

Connectivity

The megatrend toward providing students and teachers with connections to the computer networks of the world is well underway. Increasingly, educational leaders and policy makers agree that students should have connectivity to other students within and beyond the school building, and to the information sources of the world.

There is considerable agreement that libraries will become "virtual libraries"-that is, that library contents will be distributed electronically throughout the world, rather than being physically available only in isolated buildings. Such libraries will be accessible to students both in the classroom and at home. This represents a major change in the world. Already, students of all ages are learning how to make effective use of libraries that previously had only been available to a select few researchers.

The pace of increased connectivity is faster in the business world than it is in the home market. It is faster in the home market than it is in schools. When all three markets are taken together, it seems clear that both our formal and our informal educational systems will experience continued rapid growth in connectivity for many years to come. In terms of the S-shaped growth curve (see Appendix), we are beginning to enter a time of very rapid growth. It appears that this period of rapid growth will extend over many years.

Of course, there is a substantial difference between providing schools with the connectivity and thoroughly integrating effective use of this connectivity into the curriculum. The needed investment in teacher training and curriculum development will be slow in coming. Teacher training remains a major impediment to the rapid increase of effective use of information technology in schools.

Artificial Intelligence

Computers will continue to get "smarter." That is, they will grow in their capability of doing intelligent-like things. More and more problems will be solved by merely expressing the problem in a format that fits the computer's capabilities. Increasingly, the human-machine interface will make it easier to do this, and the interface itself will make use of results developed by the field of Artificial Intelligence.

There are now thousands of expert systems in everyday use. These systems are computer programs based on past successful solutions to particular problems. They have a level of "intelligence" adequate to help accomplish tasks and solve problems within a narrow scope. Such expert systems are "fragile"-that is, they only perform well within the narrow domains they were designed for. This means that people using such expert systems have to have a good knowledge both of the domain of the expert system and how to recognize a problem outside of that domain.

The capabilities of such expert systems will continue to increase. They provide excellent examples of where a person and a computer who are trained to work together can outperform either working individually.

Problems will increasingly be solved by teams composed of humans, computers, and computerized equipment such as robots and automated factories. It takes considerable knowledge and experience for a human to be an effective member of such a team. The capabilities of two of the team members (the computer and the automated equipment) will continue to increase rapidly. This places an added burden on the human member of the team. The human provides a unifying sense of purpose and perspective, and defines the overall task and the goals. This role is indispensable.

Education is faced by the problem of educating people to become integral members of the three-part team consisting of humans, computers, and automated equipment. This is not an easy educational task; it is one that our educational system has so far done little to address. In many cases the human component of this three-part team will, itself, be a team. Our schools have made substantial progress in cooperative learning-teams of students learning to learn together. Far less progress is occurring in helping students gain skills in collaborative problem solving.

Other aspects of Artificial Intelligence will have a profound impact on education. Voice input provides an example. Already, voice input is widely used in the commercial world. Educators have

little insight into how to teach reading and writing in an environment that includes high-quality voice input and voice output systems.

Hypermedia

Hypermedia is an interactive environment that includes text, color, voice, sound, graphics, and video. Hypermedia allows user interactivity in the information retrieval process. Users can choose individual pathways through information collections, and the information itself can be presented in multiple formats that better fit the needs of individual users. Increasingly, information is being stored in a hypermedia format, and this trend will continue.

Schools are embarking on a pathway in which all students will become proficient in reading (that is, using) hypermedia. Students are learning to retrieve information stored on CD-ROMs, in hypermedia computer files, in computerized databases, and on the Internet's World Wide Web. Eventually, such electronic access to hypermedia-based information will be commonplace.

Schools are also embarking on a pathway of having students learn to write (create) hypermedia documents. The trend is clear. Eventually, schools will take it for granted that reading and writing mean both the conventional paper-based and also hypermedia-based activities. However, interactivity, sound, color, still photography, computer-based drawing and painting, and video add new dimensions to communication. In total, facilitating students in developing basic skills in reading and writing hypermedia will prove to be a major challenge to our educational system. Given the limited resources and time that teachers have for acquiring and integrating these new skills themselves, schools will probably be slow to provide extensive hypermedia learning opportunities to students.

This will tend to create a situation in which some students become facile at reading and writing hypermedia, while other students develop only a reading skill in this area. As the hypermedia literate students progress through our school system, they will present a major challenge to their teachers. For example, if a teacher lacks skills in writing hypermedia, how will the teacher adequately assess the work of students that is presented in this format? How will the teacher help such students increase their skills in communicating in hypermedia?

Productivity Tools for Students

The generic and specialized computer productivity tools for adults will continue to get better and will become better interconnected. Increasingly, similar tools will be integrated into the content of the K-12 curriculum. Students will grow up using the computer productivity tools of adults. Curriculum content will reflect the capability of these productivity tools.

As noted elsewhere in this book, curriculum content and tools used to solve problems and accomplish the tasks of a discipline have always been interwoven. This will continue as computers become commonplace in the schools. Thus, we will see substantial changes in the content of the various disciplines. Some will be more affected than others, depending on how powerful the computer tool is in each particular discipline.

Because of the pace of change of overall computer capability, there will be an increased pace of change of curriculum content. The content will adjust to the capabilities of computers as an aid to solving the problems and accomplishing the tasks of the discipline.

We already see this, for example, in accounting and graphic arts coursework. The advanced math curriculum in high schools is increasingly being driven by the capabilities of handheld graphing calculators. Eventually, this calculator-driven curriculum will become a computer-driven curriculum. Because students are not limited to problems easily solved with pencil and paper, they can approach more sophisticated content earlier in their educational careers. Similar statements hold for science courses-especially those that make substantial use of mathematics.

Progress in thoroughly integrating student productivity tools into the curriculum will be slow. It requires substantial investments in teacher training, curriculum development, and the assessment system. All three of these areas of needed capacity building are currently underfunded and will continue to be underfunded.

Teacher Productivity Tools

Many different computer tools can help increase teacher productivity. Examples include word processor, electronic gradebook, databases of exam questions, lesson plans stored in a word processor, and so on. Access to the Web gives teachers access to subject matter information and lesson plans. There has been and will continue to be a steady increase in teacher usage of such productivity tools.

There is a different class of teacher productivity tools-ones that may enhance student learning and teacher effectiveness. These are the desktop presentation tools and other electronic aids to teachers interacting both with students and the curriculum in a classroom setting. We can expect substantial growth in use of teacher productivity tools.

For example, a classroom can have Internet connectivity. During a discussion between students and the teacher, either the students or the teacher may retrieve information from remote databases or from people. This type of classroom computer use is now in its infancy; it will grow rapidly in years to come.

As a second example, consider a package of mathematics software that the students are learning to use. With appropriate desktop presentation projection equipment and a computer, the teacher can interact with the whole class or with small groups of students, demonstrating key features of the software. Samples of student work can be displayed and discussed. Students and teacher can work together to explore problems, making use of the computer capabilities.

A third example is provided by having students and teachers interact electronically. Assignments and materials can be provided to students through this electronic highway. Questions can be asked and answered. Assignments can be submitted and then returned electronically.

Finally, consider computer-assisted learning and other aids to student learning. Teacher productivity can be increased by relegating certain instructional tasks to such facilities.

Technology-Enhanced Learning

Several of the components of computer use as an aid to learning are coming together to form a combination we call technology-enhanced learning (TEL). TEL consists of:

1. The combination of computer-assisted learning (with built-in computer-managed instruction), distance education, and electronic access to both information and people.

2. Aids to teacher interactivity with students and student interactivity with each other, such as desktop presentation, e-mail, and groupware.

3. Increasingly powerful student productivity tools with built-in learning aids, context sensitive help, templates, and other aids to producing high-quality products. These help a user to learn while doing.

Via TEL, more and more education will happen at a time and place that is convenient to the needs of the learner. Convenient education is a megatrend in formal and informal education.

"Just-in-time" education is a second aspect to this TEL trend. Some learning tasks take years; it is not possible to master a second language just at the point you need to communicate in it. However, many other learning tasks can be completed in a few minutes, a few hours, or a few days-just in time to apply the skills when needed. How rapidly and effectively the learning occurs depends on the background and capabilities of the learner and on the learning environment. Our educational system needs to help students gain increased skill in being "just-in-time" learners. This is an important component of learning to learn and being a lifetime learner.

A third aspect of TEL can be found in the changing capability of the informal educational system. Almost all general-purpose home computers that people purchase today come equipped with a CD-ROM drive. Microsoft's Windows 95 operating system contains built-in support of telecommunications. The trend is clear. Technology-enhanced information access will increasingly allow homes, businesses, and other informal education environments to support just-in-time and convenient education. As the amount and quality of convenient education materials continue to increase, there is the potential that more and more of the traditional content of formal education will be learned in informal educational settings. The role of formal education-and of the teacher-will change.

We can get a glimpse into potential changes by asking ourselves what are the unique characteristics of a human "live" teacher, as contrasted with CAL, CMI, distance education, and other electronic aids to learning. While there are many answers, several of the most important ones are:

1. The human-human interface. This is far better than any current human-machine interface. Teachers can know their students and interact with them in a manner appropriate to the needs of human beings.

2. The versatility of the human teacher. A human teacher can facilitate an interdisciplinary discussion that ranges over whatever comes to the minds of the students and the teacher. The human teacher has flexibility and capabilities that far exceed those of any current computer system in this regard.

3. The social aspects of education. Education is a social activity. Human teachers, along with the interactions among students and with teachers, are essential to our formal and informal educational system.

This type of analysis suggests that our formal educational system will place more of its structured efforts into making effective use of the uniquely human characteristics and strengths of human teachers. More of the subject matter content and rote skill components of the curriculum will be left to TEL.

Curriculum Content

Increasingly, computers can solve or help solve the types of problems that students study in school. The usefulness of computers as an aid to problem solving cuts across all academic disciplines. However, computers are far more useful in some disciplines than others. For example, while computers are useful tools in both art and music, they are more central to accounting, mathematics, and science.

To date, the content of the K-12 curriculum has not changed a great deal due to computer

technology. We have previously mentioned the growing role of calculators in mathematics instruction, and the toehold of the microcomputer-based laboratory in science education. The use of computer simulations and simulation games is slowly growing. Through the use of such simulations, individual students or a whole class can explore complex problem-solving situations in business, science, and social science.

Another example is provided by students learning to use electronic aids to retrieving information. Instruction in the electronic accessing of information is replacing instruction in non-electronic ways to access information. It is now clear that all students need to develop some of the information retrieval skills of a research librarian. Instruction in such skills can begin at the primary school level.

We will see a slow but steady change in the content of all academic curriculum areas due to information technology. The pace of this change will accelerate as computer facilities become more readily available to students and teachers, and as each group becomes more skilled in their use.

Preservice Education of Teachers

The National Council for Accreditation of Teacher Education (NCATE) is the main accreditation agency for Colleges of Education in the United States. NCATE is making continuing progress toward accreditation standards that will require both preservice teachers and their faculty to become computer literate. This is a trend that will continue.

More and more preservice teachers have had a number of years of computer experience while they were in the K-12 educational system. Thus, the average level of computer knowledge of preservice teachers is steadily increasing. This trend will continue.

Taken together, the two trends of this section ensure that there will be a continuing increase in the computer knowledge and skills of graduates of teacher training programs. However, this steady improvement needs to be compared against the steadily increasing capabilities of information technology in education. Right now, there is a huge gap between the needed knowledge and skills of recently graduated teachers, and their actual knowledge of computers in education. It appears likely that this gap will continue to exist-indeed, it seems likely that it will grow.

Inservice Teacher Education

One way to talk about a particular specialized education is to quantify its "half-life." Suppose that a person gains the knowledge and skills to be fully qualified as a neurosurgeon or a cardiologist. Suppose that this person then gains no new knowledge or skills, while the contemporary standards continue to increase. How may years will it be before this person is only "half-qualified?" While such a quantification is not particularly scientific, it does provide a basis for analysis and discussion. The

half-life of a neurosurgeon or a cardiologist might be in the range of 3 to 4 years.

What is the half-life of a teacher's education? How is it affected by the rapid pace of change in the totality of human knowledge or by changes in technology? Although we do not have precise answers, it is clear that the rapid pace of change in technology has greatly shortened the half-life of a teacher's education.

At one time, it was common for teachers to obtain lifetime teaching certificates. In more recent years, most states have put in requirements that a teacher have some continuing teaching experience and a certain amount of coursework or other training for certificate renewal.

Information technology in education has added a new and perplexing dimension to this picture. Information technology is affecting both the content and the pedagogy of every discipline at every teaching level. Moreover, it is not easy to develop the needed knowledge and skills effectively to integrate the technology into the everyday curriculum. The facility with which some students pick up technology skills often serves to increase pressure on the educator, as traditional roles of teacher and learner are disrupted.

Our inservice teacher education system was not designed to deal with a rapid pace of change. It is proving inadequate in dealing with computer-based technology. Unless there is major restructuring in our inservice education system, there will be a growing gap between the potentials of information technology in education and the actual implementation. At the current time, there is little indication that the needed restructuring of our inservice education system is occurring.

The analysis of preservice and inservice teacher education leads to a forecast of a continuing major gap between information technology knowledge and skills needed by teachers and their actual knowledge and skills.

The School-Home Connection

Computers and connectivity are having a significant impact on the "home" part of our formal and informal educational system. Current estimates are that close to half of the school children in this country have access to a computer at home. This suggests that there are several times as many computers in the homes of school-age children as there are in our schools. It also means that there is substantial inequity in students having access to the technology. Those students who come from a home situation where there is a computer and parents who know how to make effective use of a computer may be receiving several times as much instruction and experience with computers as those students from other homes.

The following two news items suggest that computers and connectivity will continue to grow in

the homes of school-age children.

Education is Key to Home PC Market

An American Learning Household Survey says that over 80% of intended family household PC buyers in its study cited children's education as the primary reason for purchase, relegating work-at-home and home financial applications to a distant 40% level. The survey also found that children's use of the PC is shifting away from games and toward more complex uses of the computer as an information access tool.

The Red Herring. (1995, December).

Sega Will Add Browser to Gaming Equipment

Sega Enterprises plans to add equipment to its Saturn video game console that will enable consumers to browse the Internet on their TV set. The entire package would cost between $100 and $150 more than the current $299 Saturn price tag.

Investor's Business Daily. (1996, February 16). p. A30.

The news item about Sega Enterprises is especially interesting, as it suggests that we may move rapidly toward integration of entertainment and non-entertainment systems. The computing power in a game machine rivals or exceeds that in many of the general purpose microcomputers. Such computing power can be used for more than just playing games.

Educational software developers are well aware that there is both a school market and a home market for their software. Increasingly, these developers have come to realize that the home market may exceed the school market.

Of course, the home and the school markets for educational software are by no means the same. The term *edutainment* has been developed to describe software that has a combined educational and entertainment focus. If an educational product is being developed primarily for the home market, the entertainment components may well dominate over the educational components. There is relatively little solid research to support the educational value of many of the educational games that are widely sold to parents and children.

Conclusions and Recommendation

As you make use of the educational technology forecasts in this chapter, keep in mind that they are mainly forecasts based on expert opinion. Each forecast represents a potential-something that schools could be doing right now. One can summarize these forecasts by asserting that the student and teacher goals for information technology given in Chapter 4 will eventually be achieved. These

goals will help guide our educational system over the next few decades.

The forecasts have a unifying theme-moving from first-order effects to second-order effects. Some schools and school districts will move much faster than others. However, it seems clear that our educational system as a whole is going to move toward the second-order effects, and then beyond them.

These will produce substantial disruptions in our current educational system. The planning and change process needs to be given careful attention. Strategic planning is discussed in Chapter 9.

The next chapter considers some of the ramifications of moving our curriculum, instruction, and assessment in the forecast directions.

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From Presentation to Programming

Doing Something Different, Not the Same Thing Differently

Rather than using MicroWorlds just to do a presentation on dolphins, students use MicroWorlds to simulate a highly realistic ocean ecosystem complete with dolphins.

By Cathleen Galas

"Would you rather that children learn to play the piano, or learn to play the stereo?" asks Mitchel Resnick of the Media Laboratory at the Massachusetts Institute of Technology. "The stereo has many attractions: It is easier to play, and it provides immediate access to a wide range of music. However, 'ease of use' should not be the only criterion. Playing the piano can be a much richer experience. By learning to play the piano, children learn to express themselves in new ways. They can continue to learn and develop over time, adding new complexity as they improve. In doing so, they are more likely to learn more about the deep structures of music" (Resnick, Bruckman, & Martin, 1996).

Doing the Same Things Differently

In classrooms all over the country, overburdened teachers are rushing to provide "stereo" instruction to children. In other words, they are under the impression that children who use multimedia software on computers—rather than create their own materials—will learn more and learn better. Such instruction has been touted as necessary to help students move into the 21st century with the right technological skills.

Multimedia software may indeed allow students to present information. It is easy to use, and it can help students produce exciting presentations quickly and beautifully. Such programs offer a rich assortment of tools that help students present their learning; graphics, photographs, audio, and even video formats all enhance their presentations. Students can make their reports come to life with outstanding multimedia capabilities.

These presentations, however, are still presentations. Using these multimedia tools, students are still just learning to play the stereo. For example, a stereo presentation on dolphins might show cards with images and information, and even hypertext buttons with dolphin sounds. These cards show the information researched and read by students. Children are doing the same things that students have done for many years—they're just doing them a different way. Their presentations are more exciting, motivating, and interesting because of the added features, but they are still just presentations.

Doing Different Things: Constructivist Technology

When students learn to play the piano, they use the instrument as a tool to create their own music. They spend time learning about music and eventually learn to manipulate musical structures, interacting with the piano and the music. Using a similar process—"tool" computer software—students can build and manipulate, rather than just present, and thus learn to play the piano. They use software to create their own environments that can be manipulated and changed.

For example, using MicroWorlds 2.0, which is based on the Logo programming language, children have built an ocean ecosystem complete with dolphins. They have been able to program "what if" situations and rules by which the ecosystem operates. If the food supply changes, so does the dolphin population. In this way, one group of students studied protective adaptative behaviors in marine animals. Dolphins threatened by sharks protected themselves and their offspring in unique ways (see Figure 1). These simulations of dolphins

required conceptual understanding, higher level thinking skills, and the ability to interact with the system according to its own special rules. This learning by building personal understanding is the basic tenet of constructivist philosophy.

An Instructional Paradigm for Doing Things Differently

Project-by-design programs, which are in the forefront of educational research worldwide and readily funded in the United States by the National Science Foundation (NSF), use technological investigative methods to help children learn to play the piano. These projects have similar design features: choice of topics, group collaboration, long-term projects, and artifact production (usually a project, model, or simulation). Most are at the middle school or high school level.

Project-Based Learning Environment

At Seeds University Elementary School, the laboratory school for the University of California at Los Angeles Graduate School of Education and Information Studies, students are working with computers and technology in a multiyear NSF project by design. Yasmin Kafai is the principal investigator; she is aided by graduate students Sue Marshall and Cynthia Ching and classroom science teacher Cathleen Galas. Using MicroWorlds, we have been working with fourth, fifth, and sixth graders to provide conceptual science explorations and experiences through student constructions of collaborative and interactive technology projects.

Overview of Project

When a project begins, students learn not only basic Logo programming concepts used in MicroWorlds 2.0 but also aspects of software design. Students get their first programming practice in teams. They learn how to use graphics tools, and how and why buttons are used to go a new page. They also learn the difference between using buttons or turtles, and that single-line instructions can be displayed when a program user connects with a turtle or button. Students practice creating text boxes and learn the basic commands to control the turtle. Finally, they learn that procedures are necessary to make more than one thing happen at the same time. Students are thus motivated to learn to make the following simple two-part procedure:

```
Procedure example:
to ________ (run)
end
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More advanced programming occurs as students develop a need to know. They ask the teacher, other adults, or peers, or they check the available manuals to learn advanced programming techniques. For example, if a student wishes to show a change in the food supply, then he or she learns to program a "slider" that moves in either direction along the same axis to show an increase or decrease in the food supply. The programmer then writes in the rules, the "what ifs" that result if the supply changes. Users can move the slider to discover what happens in various food situations, thus building their understanding of food web relationships.

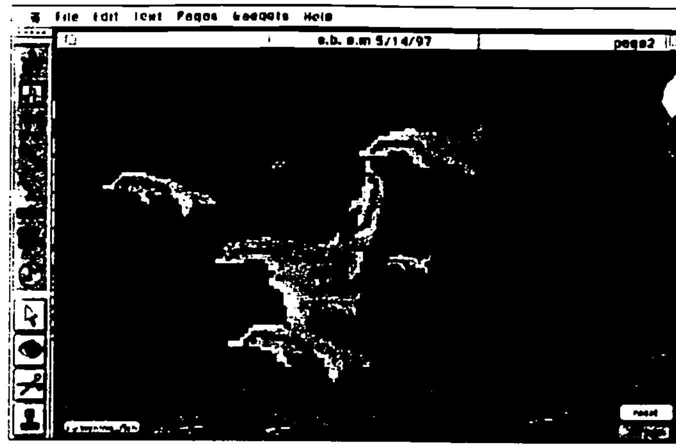

Figure 1. This screen illustrates a dolphin pod defense. Some dolphins move vertically up and down while others circle to keep the young dolphins close to the group. The tactic is confusing to the sharks.

Second, a specific topic is introduced. As a group, students generate many "wonder" questions that can be refined into the students' personal "driving" questions of inquiry. Elliot Soloway, professor at the University of Michigan's Foundations of Science, uses this term to define deep, personally relevant inquiry questions that are suited for long-term, project-based science projects. Students fill out applications for team jobs and are assigned to teams of three to five students. Each team has a computer and an adjoining work area where planning boards and materials are available; here they start mapping out their ideas and timelines for their projects. Collaborative team-building activities help students work effectively in unison to construct their projects. Ongoing team-counseling activities help to resolve conflicts and mediate differences in individual student agendas.

Learning activities are large-group, small-group, and independent. Students may participate in some activities or experiments that the teacher assigns, and they may also design their own experiments, investigations, or research. The student-centered design and on-demand learning aspects of the projects require considerable teacher flexibility in this model. The teacher must not only understand the topics but also act as an information provider, guide, and interpreter. Before the unit, I collected many Web addresses for oceanography and marine biology sites, and then made them available to students from our own classroom Web site. In addition to discussing our experiment results, we examined the research found on the Internet and discussed the e-mail responses from marine biologists who worked with each group.

Third, students brainstorm their wonder questions in oceanography and marine biology. Small groups then meet to discuss specific research interests. A clipboard is available for students to write lesson requests. The first items on the list of our most recent marine biology unit were "food webs" and "how do animals adapt to different conditions in the oceans?" These request

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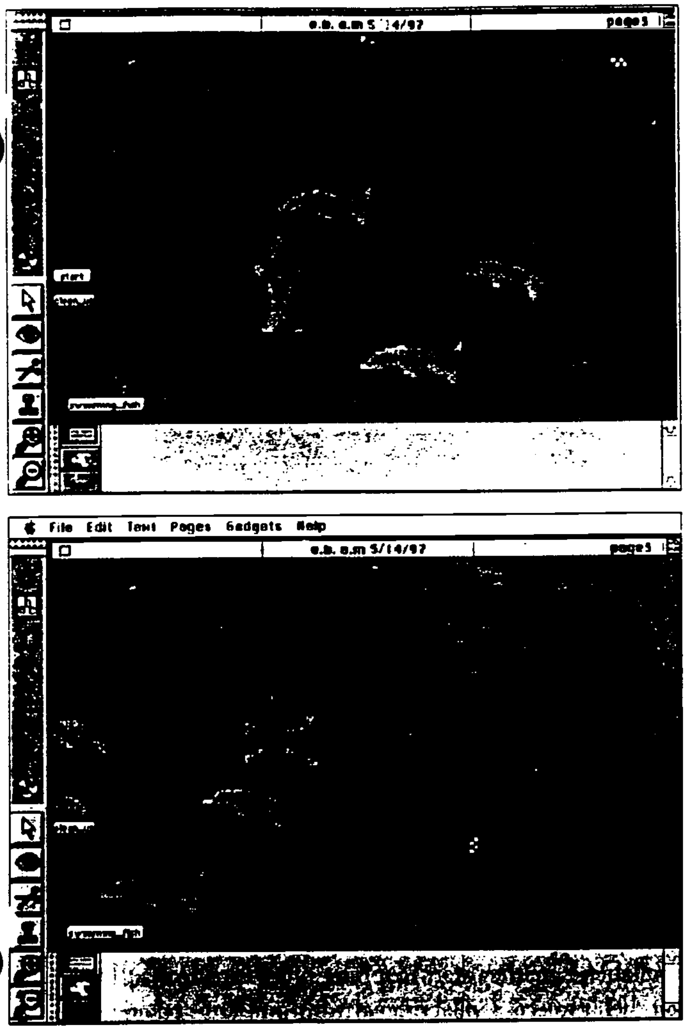

Figure 2. These screens show oil spilling into the ocean. The simulation shows dolphins ingesting the oil and the resulting toxic effects.

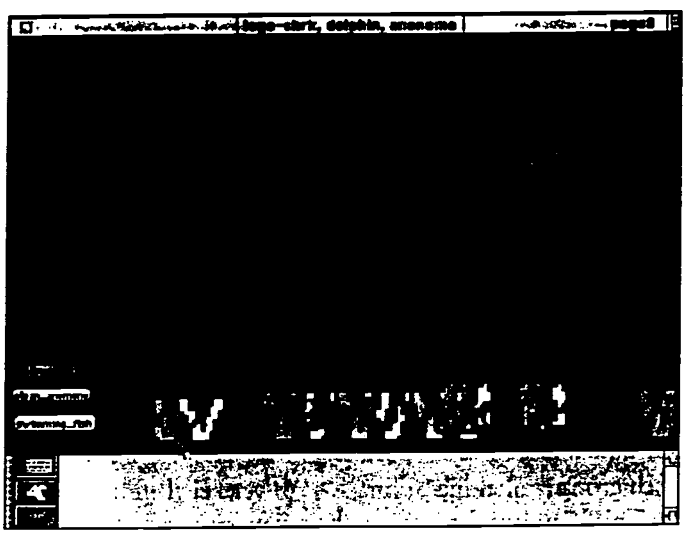

Figure 3. This simulation illustrates adaptive behaviors by showing clownfish safely swimming among sea anemones. The clownfish behavior attracts another fish, which believes the anemones to be safe. The fish is stung and eaten by one anemone.

items coincided with my overarching goals for student learning, so I planned specific lessons on food webs and adaptation.

Teacher-centered required lessons on ecosystems and current events led into a series of lessons and discussions requested by students. For instance, some expressed interest in human behavior effects on ocean life in Santa Monica Bay and along the California coast, and the discussion led them to oppose the expansion of a salt mine in Baja California, Mexico, because it had been predicted the project would have negative effects on gray whales in the area. Student activists then began independent research on ways to protect the ocean environment. Several group projects, in fact, revealed environmental-protection concepts. One project even animated an oil spill, showing the ensuing death of marine life in the area (see Figure 2).

Some experiments and activities were hands-on, and some were virtual (largely those developed through Internet resources). We took a real field trip on a research vessel and conducted various experiments on the water and ocean floor, viewed plankton through microscopes, and carefully gathered marine specimens for discussion. Other real and virtual field trips allowed us to view marine habitats, discuss adaptations, and learn more about human impact on the ocean environment. The entire class virtually dissected squid, identified whales on video, reconstructed marine mammal bones, and visited ocean museums. Students also asked to clean the beach on one of our real ocean visits. One project created after this trip showed a littered beach with a "clean-it-up" button. When a user clicked on the button, a hand actively picked up all of the trash on the beach and deposited it in a beach trash can.

In the classroom, we used the Internet as one resource for information and interactivity. To set the stage in oceanography, we began with whole-class activities that acquainted students with the world's oceans, the water cycle, and the ocean floor. Small groups met to view ocean color from space via the Internet, completing ocean map activities online and discussing and coloring maps using current satellite information. An online current activity allowed students to track real-life drifter buoys to see the directions of ocean currents. Students also took a virtual ocean habitats tour courtesy of the Monterey Bay Aquarium, interacted with ocean maps that showed trenches and tectonic-plate movement, and played an online aquatic environment game. When one student brought in his tadpoles for the class to observe, the entire class met to discuss coming changes. We looked together at pictures, diagrams, and videos available on the Internet, and then posted Web sites for interested students to pursue. Some groups explored the whole frog project, and some decided to participate in the virtual interactive frog dissection. Whole class lessons and activities were reserved for concepts that were important for all students. Activities were different for various groups, depending on their research questions; some activities were optional for those who were interested.

Students also are designing software for both their own learning and an audience. During the unit, students must show their projects to their groups, the class, and younger students as part of a "usability study." These younger students use the computer projects and give feedback to each group on the software's ease of use, what they learned, and whether the older students are communicating the understandings and knowledge well. These "reality checks" help students evaluate their progress, their goals, and, ultimately, their own learning.

Students Designing Software

Students who design software simulations and models learn about science in a way that connects information more meaningfully. Learning *about* dolphins brings a deeper understanding than studying disconnected facts about the kinds of dolphins and their diets and habitats. When students learn about dolphins and have to build and connect those pieces of research into a computer ecosystem, they learn the interrelationships of the information. When they explore how temperature, food supply, and numbers of predators in the environment combine to affect the dolphins' existence, the students learn about systems in science at a conceptual level, because they must understand connections and relationships if they are to construct an accurate model. When they just present information, they do not demonstrate true understanding. They are simply recalling information they have read or heard.

One major difference in project-by-design science is that students pursue their research and work on a project during the unit itself and not as a culmination activity after a science unit. Therefore, as students participate in teacher-directed activities or pursue their own research interests, they continually apply concepts to the structure of their project. Students must explain how the information or new ideas—their evolving understandings—relate to their project.

Bridge to Their Future

In many schools, teachers are scrambling to use technology in their curriculum. To meet a perceived demand, software designers are giving away stereo software for teachers to use. It reminds me of an ancient Chinese proverb: "If you give a man a fish, he has food for a day; if you teach a man to fish, he has food for a lifetime." If we just give our students presentation software, then our students will eat for a day. When we teach our students the skills to construct high-level, connected, and conceptual understandings, they can build their own bridge to the 21st century.

As a result, we will not be doing the same things differently, we will be doing different things with our technology. We will be providing tools that bring different outcomes. We will teach our children to fish and to play the piano. They will never be hungry, for they will feed on their own abilities to learn what is necessary to cross the bridge into the next century. We can give our students "piano" software tools that we can learn to play together. We can act as guides in the learning process instead of all-knowing information givers. We can respond to student questions on demand and help students discover and understand through their own investigations. In this way, our students may feast on a variety of wondrous music of their own creation, consuming their own and their peers' bountiful harvests of understanding, masterfully tickling the ivory keys of technology to manipulate, model, and simulate problems and solutions in the next century. As futurist David Thornburg suggests, we as teachers can truly provide students the real tools of technology to cross the bridge to their future instead of our past. ■

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Reference

Resnick, M., Bruckman, A., & Martin, F. (1996). *Pianos not stereos: Creating computational construction kits* [Online]. Available: http://el.www.media.mit.edu/groups/el/papers/mres/pianos/pianos.html.

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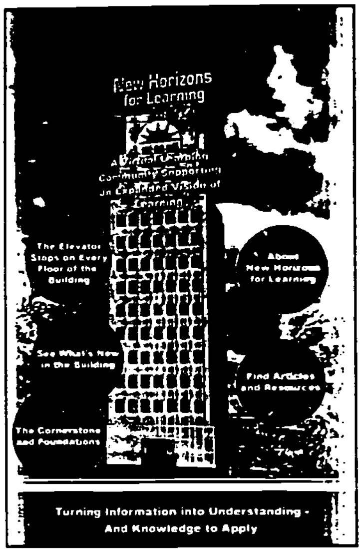

Image created by Dylan Glockler and Jamey Baumgarat of Eclectic Internet (info@eclectic4.com)

In This Virtual Building, the Learning Is Real

By Dee Dickinson

WHAT WOULD HAPPEN TO SCHOOL SYSTEMS AND STUDENTS IF EVERYONE TRULY BELIEVED THAT THE HUMAN BRAIN CAN CHANGE STRUCTURALLY AND FUNCTIONALLY, FOR BETTER OR WORSE, AS A RESULT OF LEARNING AND EXPERIENCE? AND THAT INTELLIGENCE IS NOT A STATIC STRUCTURE THAT CAN BE MEASURED AND GIVEN A NUMBER BUT AN OPEN, DYNAMIC SYSTEM THAT CAN CONTINUE TO DEVELOP THROUGHOUT LIFE? IF WE HAVE LEARNED THAT THESE CHANGES ARE POSSIBLE, THEN WE NEED TO ASK WHAT CONDITIONS AND STRATEGIES MAKE IT POSSIBLE FOR ALL STUDENTS TO LEARN SUCCESSFULLY. THESE QUESTIONS HAVE DRIVEN THE WORK OF NEW HORIZONS FOR LEARNING SINCE ITS INCEPTION IN 1980.

In the late 1970s I was chair of an advisory committee to the superintendent of a large urban school district in Washington State. The mission of the group was to make recommendations on ways to raise the academic quality of the schools. We were given access to information from all sources and encouraged to interview administrators, teachers, and students and to visit classrooms throughout the district. The more we learned, the more discouraged we became.

At that time there was an explosion of new information from cognitive research, studies of human development and the brain, analyses of individual differences in how people think, learn, and behave, and new developments in effective teaching and learning strategies, including accelerated learning techniques. But our committee found that little of this information was reaching teachers or students, and hardly any of it was guiding staff development, planning, or practice.

In 1979 we heard about an education conference of the World Future Society in Minneapolis. The superintendent sent two of us from the committee and the assistant superintendent of curriculum and instruction there for a week, and we hardly needed a plane to fly back home. At the conference we learned all we could from education trailblazers who were involved in research projects on learning and human development. Much of this work validated the multisensory activities used intuitively by many teachers and administrators who until then had seen no research to explain why they were so successful at helping their students learn.

Creating a Network

Although we were highly motivated to communicate and put into practice what we had learned, it soon became clear that district personnel weren't ready to move forward in the ways we envisioned. So we decided to start an educational network to reach teachers with the kind of information we ourselves would love to have had when we were in the classroom.

Much of this work validated the multisensory activities used intuitively by many teachers and administrators.

In 1980 we founded New Horizons for Learning. Its express mission: to seek out, identify, communicate, and help implement more effective teaching and learning methods so that all students might become successful

learners. We began publishing a newsletter with short articles, often translated from "researchese," describing effective strategies, the persons who had developed them, how the strategies were being used, what outcomes were resulting, and where to find more information, along with names, addresses, and phone numbers.

It was as though we had put up a lightning rod that attracted highly charged, dedicated people who had at last found a way to communicate with each other. We realized that our most important work was to facilitate these connections and offer ongoing resources. By the second year we had a thriving international circulation for our *On the Beam* newsletter and our phones were busy with calls from people asking for more information and describing projects they had under way.

We brought in innovative researchers and practitioners to give workshops and seminars. When it became clear that information alone would not be enough to bring about change, we held monthly meetings in local schools to bring together growing numbers of teachers who wanted to move forward and support each other in the process of implementing new approaches to learning.

It was as though we had put up a lightning rod that attracted highly charged, dedicated people who had at last found a way to communicate with each other.

We became increasingly troubled that too many children of normal intelligence were entering school without the abilities and skills they needed to be successful learners. We set up a nationwide research project to discover what kinds of help new mothers were receiving in maternity units of hospitals and birthing centers. It turned out there were numerous programs on how to diaper, feed, and bathe babies but few on how to create environments that were nurturing, stimulating, and productive of healthy mental, emotional, and physical development.

About that time the Northwest Area Foundation asked if there was a project we'd be interested in doing. We were ready to go, and soon we embarked on the planning and production of a video program, *Day One*, to help the information gap we had discovered. We worked with prominent neonatologists, baby nurses, and pediatricians, found a television producer who was interested in working with us, produced the program in two 15-minute segments (to accommodate the brief attention span and busy schedules of new mothers), and pioneered the project in a large hospital.

Day One *is still being used nationwide in hospitals and maternity centers, and it spawned Spanish, French, and Hebrew versions for use in other countries.*

We used a cadre of trained volunteers who met for discussion sessions with the mothers after they viewed the program. We made human interaction as well as technology an essential part of the program.

Research showed that the program was having positive results, and we began its distribution. *Day One* is still being used nationwide in hospitals and maternity centers, and it spawned Spanish, French, and Hebrew versions for use in other countries.

Putting It Together

Day One was premiered at another important event in New Horizons' history: a major conference on new developments in education.

In November 1983 we received a call from Robert Schwartz, director of New York's Tarrytown Conference Center, which was famous for its seminal conferences on topics ranging from politics and the economy to new physics and the arts. He asked if we would be interested in creating a leading-edge conference on education. Needless to say, we were delighted.

We called the conference "The Coming Education Explosion" and brought together a distinguished group of 35 researchers and practitioners from around the world as presenters. Howard Gardner's just-published *Frames of Mind*, setting forth his theory of multiple intelligences, became the framework.

Schwartz, in his conference introduction, said: "At a time when the 'Back to Basics Express' seems to be roaring full steam backward, Tarrytown is pleased to present a forward-looking conference which takes a view that the real purpose of education is to develop more fully the innate capacities of every individual." Many of the conference presenters

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became members of New Horizons' international advisory board and continue to advise us today.

We secured a grant to send 75 key persons from Washington State to the conference, and they became the driving force behind a series of state conferences called "Creating the Future in Education." Each conference was built around Gardner's theory of multiple intelligences, so participants themselves learned in many different ways as they explored new ways of teaching. At each conference we learned more about learning from attendees as well as presenters. After the conferences we offered ongoing resources to attendees through our network.

In our unstable world we see many examples of highly intelligent and well-educated people who lack humane qualities.

At that point, technology had not yet intervened in our work routines, so our newsletter was a cut-and-paste process and communication was by mail, phone, and fax. Looking back on it, it was pretty cumbersome. Our offices were crowded with filing cabinets, bookshelves, and boxes filled with articles and research papers.

Imagining the Future

At a conference of the International Association of Accelerated Learning in Rio de Janeiro in 1985, we participated in the creation of a global charter on educational reform for presentation to all countries of the world.

"Every human being shall be guaranteed opportunities to develop his/her capacities to the fullest extent possible through formal and informal education as a life-long process," the charter's preamble states. So that teachers can have available the "most current, well-researched information on teaching and learning," it called for the development of a worldwide databank "to facilitate the sharing of this information" in any language.

The preamble added: "Educational systems utilizing this information must help each individual to learn how to learn and how to think analytically and creatively in order to help each country solve the complex problems of our time, not only locally but globally. World peace depends on the fullest development of each human being in mind, body, and spirit."

At that time we didn't have the technology to accomplish what the charter envisioned, but the possibility remained in our thoughts as New Horizons expanded its newsletter, published books and other materials, continued to connect people and ideas, communicated their successes, and celebrated new models of learning.

Going Electronic

Four years ago, New Horizons gave up its offices and launched into cyberspace. Our network manager, Teri Howatt, taught herself how to work with the new technological tools, and that transformed the way we worked. The files and shelves and boxes disappeared into databanks. *On the Beam* got wired, and email mostly replaced U.S. mail.

As the World Wide Web mushroomed, it became possible three years ago to build a prototype of what might one day become that global databank envisioned in Rio. When Teri Howatt learned how to put together a home page on the Internet, we created a Web site using the metaphor of a Building—using building more as a verb than a noun.

Our network has evolved into an interactive learning community which anyone anywhere in the world can freely access. Once there, community members can find or offer current information, learn how to apply it, and find mentors to work with.

Brains and Needs

The cornerstone of our Building comprises the new understandings we have gained about how the human brain and intelligence are affected by learning and experience. We recognize that intelligence resides not just in our heads but in all parts of the human body, in our interactions with other people, in the resources in our environment, and in the tools we use, including the new electronic ones. We consider these principles to be fundamental in the task of creating educational systems that are right for our times.

Developing intelligence is not enough, however. In our unstable world we see many examples of highly intelligent and well-educated people who lack humane qualities. At the extreme,

New Horizons for Learning

New Horizons for Learning, founded in 1980, is an independent, international network of people involved in teaching and learning in schools, homes, businesses, and communities. It is a nonprofit organization whose work is done primarily by volunteers. The mission of New Horizons is fivefold:

- To act as a catalyst for positive change in education.
- To seek out, synthesize, and communicate relevant research and information.
- To support an expanded vision of learning that identifies and fosters the fullest development of human capacities.
- To help implement proven strategies for learning at every age and ability level.
- To build support for comprehensive lifespan learning communities.

Now an electronic learning community, New Horizons has constructed a virtual Building on the Internet that has floors focused on various aspects of learning at every age and ability level in a variety of contexts. The Building publishes a bimonthly electronic journal—*On the Beam*—focused on lifelong learning. The newsletter features articles by contributors from the New Horizons network. The site is hyperlinked to related resources throughout the world.

The network manager is Teri Howatt. Micki McKisson Evans is president, and Dee Dickinson is CEO.

The New Horizons Internet address is *www.newhorizons.org*. The email address is *building@newhorizons.org*.

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there are those who are capable of hostile and violent acts against others.

It might be good for all of us to keep in mind psychologist Abraham Maslow's hierarchy of human needs and how self-actualization develops. We know that empathy, understanding of others, compassion, generosity, integrity, and eventually wisdom do not develop spontaneously. They begin developing early in life through observation of the behavior of good role models, and they are learned by doing. But first, basic human needs must be attended to—shelter, safety, a sense of belonging.

A New Kind of Learning Place

The critical needs of today's challenging school populations make it difficult to imagine a place where everyone is able to learn. Children who live in poverty, experience violence in their lives, do not have proper food and clothing, and have no appropriate role models find it difficult and often impossible to learn.

Because schools alone cannot deal with such problems, there is a growing need for community learning centers linked to social-service, health, welfare, cultural, and recreation agencies. Such centers are being developed in many parts of the U.S. and in other countries.

We see the New Horizons electronic learning community as a resource for this kind of learning place. The resource book and documentary *Learn and Live*, produced by the George Lucas Educational Foundation, describes some of these places.

The critical needs of today's challenging school populations make it difficult to imagine a place where everyone is able to learn.

A Vision Fulfilled

Years ago, Malcolm Knowles, author of *Androgyny in Action*, envisioned "learning systems" capable of bringing about their own continuing transformation in response to changing needs. He saw them linked to community agencies, other places of learning, libraries, museums, and workplaces. Educators in new roles would become key community professionals, and the entire community would become interlinked through learning. Today's technology makes Knowles's vision a reality, as an unlimited number of organization are able to communicate, access information, collaborate, and keep ongoing records of results to feed back into the system.

Learning centers, jointly funded, offer stimulating and nurturing environments filled with human helpers and a variety of technological tools, humanized through enriching art experiences and open to learning in the community and the natural environment.

We at New Horizons are well aware that what we offer has little value unless it takes form in practical applications.

Students, developing and using all of their intelligences in these environments, learn how to learn, to construct meaning that they can turn into knowledge for application in a variety of situations. They take responsibility for their own learning as they access information from a wide variety of sources, both natural and electronic.

The Internet and other multimedia resources offer up-to-date information not available in any textbook. Service projects, internships, and explorations of the natural environment offer real-life learning facilitated by collaborative groups as well as technological tools.

As a result, teachers explore new roles as they help students identify and develop their strengths. They become knowledge brokers, helping students to master basic skills, apply what they have learned, and develop higher-order thinking processes. Teachers also facilitate their students' lifelong learning and human development.

We at New Horizons are well aware that what we offer has little value unless it takes form in practical applications, so we work in the field with both students and teachers. Our electronic building continues to add new stories and become more interactive as we pilot new tools, such as the Distributed Dialogue Processing System developed by David Boulton, founder of 2 Way Corporation and designer of the Apple Electronic Campus (*www.implicity.com*).

We continue to explore together with other individuals and organizations how to engage the power of technology and the power of the human mind, body, and spirit in creating educational systems that make possible a positive future for humanity. ◄

The full text of the global charter on educational reform is available on the New Horizons Web site *www.newhorizons.org*.

The *Learn and Live* book can be read online at *http://glef.org*, and the book and documentary set is distributed by the Lucas Foundation.

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Where Do the Learning Theories Overlap?

Multiple intelligences, learning styles, and brain-based education are distinct fields of study but share similar outcomes in the practical environment of the classroom.

Let's visit three schools. As we walk from classroom to classroom in the first school, we see students working on a variety of projects. In one room, a mural is in process; in another, a group of learners is building a bridge with various materials. Throughout the school, we see student work. In the library, many students' completed projects are on display. Sometimes we observe learners working together, other times alone. Older students are often working with younger ones. With some work, students are following structured directions; other times, they seem to be creating as they go along.

In the second school, groups of students are working at various learning stations. Some are sitting quietly, listening to tapes or working on written materials; others are playing games; still others are doing experiments and recording responses. The complexity of the tasks varies by age of the students and the content they are studying. In one classroom, the students are involved in a class meeting to discuss plans for their work at the centers.

In the other school, the visual displays make it immediately clear what content each class is studying. One primary grade is learning about desert animals. In an intermediate grade, the students are studying the culture of China. In another class, students are working on measurement. From classroom to classroom, we note a variety of group structures. Some students are working with a partner, some in small groups, and others in a large group with a teacher or older student directing the activity. In many classrooms, music is playing. Artwork is displayed throughout the building.

Three schools and three pleasant learning environments—with many common features: In each school, we find students actively involved in their learning, teachers talking with learners and with one another to make decisions and solve problems, students learning in a variety of ways, multiple resources available, displays of students' artwork, curriculum related to interests of students, parent volunteers working with learners, and regular assessment of the students' work as an integral part of the learning. When we talk to parents, they tell us about their satisfaction with their children's academic successes and with the emotional support the students feel at each school.

What is the mission of each of these schools? What are the goals and the beliefs? What was the catalyst for their particular approaches to learning? In one school, the teachers have studied and worked together to apply the theory of multiple intelligences; in another school, teachers are applying theories of learning styles; and in the third school, the teachers apply theories of brain-based education. Can you tell which school is committed to which of these theories by the descriptions of the visits?

Areas of Overlap

If we visited each of the schools for a longer period of time and talked with the teachers in depth, we would hear both similarities and differences in their beliefs and practices. Multiple intelligences, learning styles, and brain-based education have particular theoretical constructs, research bases, and applications. These fields are distinct and separate from one another in some ways, but in the practical environment of the school classroom, which calls for the application of the theories, the outcomes look strikingly similar.

Educators who believe in the concepts of learning styles, brain-based education, and multiple intelligences bring an approach and attitude[1] to their teaching of focusing on how students learn and the unique qualities of each learner. Each of these theories offers a comprehensive approach to learning and teaching, not a one-shot program. Each can be a catalyst for positive student learning. Each forces us to examine our values about people, learning, and education to make the hundreds of daily decisions that put beliefs into practice. What are some of the commonalties of brain-based education, learning styles, and multiple intelligences? I propose six areas of overlap.

Each of the theories is learning and learner-centered. The learner is the most important focus of the educational system. In an appropriate way, students are the center of attention. Schools that are learner-centered focus their energies on helping all students to be successful learners. They weigh decisions about struc-

ture, rituals, routines, class composition, curriculum content and materials, and assessments and evaluation for their effect on the learners. Conversations center on learning. Outcomes emanate from the learners' needs and interests. Curriculum is organic, not preset to be covered in a specific time. The learning process is the dominant focus.

The teacher is a reflective practitioner and decision maker. In order to appropriately apply learning styles, multiple intelligences, and brain-based education, teachers must understand the theories, continue to study them, reflect upon them, and make appropriate applications for their own students and their own situations. The principles of the theories are a rationale for decisions and a catalyst for continual examination of schooling practices. Teachers have frequent and challenging conversations about their work.

The student is also a reflective practitioner. Students talk about their own learning and are active in the planning and assessment of the learning process. They are engaged in exploring, experimenting, creating, applying, and evaluating their ways of learning, as well as interacting actively with the content and concepts they are studying.

The whole person is educated. Teachers pay attention to the cultural, physical, social, and emotional life of the learner as well as to his or her academic life. Each of the theories promotes personalization of education by connecting the student's total life to the learning in the classroom. Educators acknowledge developmental stages and consider them in instructional and curriculum decisions. Respect for every individual is paramount and is evident in the climate of the school, including its management and its discipline procedures. When a child has a learning problem, comprehensive knowledge about the student becomes the basis of a solution.

The curriculum has substance, depth, and quality. Basic skills are [t]reated seriously and frequently learned [in t]he context of appropriate applica-

> Each of the theories promotes personalization of education by connecting the student's life to the learning in the classroom.

tions. Schools spell out high and sometimes uniform standards for learning outcomes, but they consciously avoid standardization of curriculum and methodologies. Proponents of brain-based education, learning styles, and multiple intelligences convincingly demonstrate that accommodating the students' learning strengths and individual intelligences and attending to ways the brain absorbs and processes information result in more effective learning.

Each of these theories promotes diversity. It is a core principle in each theory that individuals are unique and that this uniqueness has an effect on students' various ways of learning. Teachers and students celebrate and foster diversity.

Common Cautions

Each of these theories also offers similar cautions. None pretends to be the single panacea to educational dilemmas. Proponents of learning styles, multiple intelligences, and brain-based education acknowledge the importance of good, solid teaching skills. Those practicing these theories neither discard research nor the wisdom of the past. Rather, they integrate current promising practices into the applications of the theories.

Each theory also, while it presents specific terms, labels, and vocabulary, cautions against simplistic applications of those terms. The original researchers of the theories continue to explore and develop their ideas and they warn against trivial quick-fix practices in the name of the theory.

Finally, none of the original theories aims to be a cookbook approach to teaching. When a theory about how people learn turns into a standardized program, it is a contradiction in both philosophy and practice.

The bottom line is that learning is a complex process and students learn in various ways. The teacher who acknowledges and actively responds to these truths will facilitate learning success for more learners. The theorists and promoters of brain-based education, learning styles, and multiple intelligences can contribute to effective applications by pointing out the complimentary aspects of their work. The primary message should be the need for serious understanding of the learner and the learning process.

Currently, too many students are not learning successfully in our schools—for a whole variety of reasons. Application of the theories of multiple intelligences, learning styles, and brain-based education offers more students the opportunity to succeed by focusing attention directly on how they learn. This priority is long overdue in our schools. We would be wise to keep the common principles of the theories of multiple intelligences, learning styles, and brain-based education in mind and not let competitiveness and differences among vocabulary and specific applications threaten the positive impact for teachers and students. ■

[1]For a discussion of approach and attitude, see Pat Burke Guild and Stephen Garger, *Marching to Different Drummers* (Alexandria, Va.: ASCD, 1985).

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TECHNOLOGY and POWERFUL ideas

The real value of computers is in helping us understand the powerful ideas that force us to change our ways of thinking

BY ALAN KAY

PHOTOGRAPH BY AARON GOODMAN

A few years ago, researchers from the National Science Foundation (NSF) decided to visit a Harvard commencement and ask questions of the graduating seniors and some of the faculty. The questions had to do with simple, observable scientific phenomena—what causes the seasons, for example, or the phases of the moon. Of the 23 graduating Harvard seniors, 21 had serious misconceptions about both the seasons and the phases of the moon. NSF researchers made a video of this little experiment and used it to show how common scientific misconceptions are, even among educated people.

When I first saw this video, I kept waiting for the researchers to ask what, to me, was the obvious next question. They never did, so I tried the same experiment with a group of graduate students at UCLA. I went through the same routine questions, and I got roughly the same results: About 95 percent had serious misconceptions about the seasons and the phases of the moon. Most of them thought the seasons were the result of the earth's elliptical orbit—when we're closer to the sun, they said, it's summer, and when we're farthest away, it's winter.

But then I asked the question that NSF hadn't asked: "When it's summer in North America, what season it is in South America and Australia?" Everyone knew the answer was winter. Then I just waited while it slowly dawned on them that the change in seasons could not possibly be caused by a change in distance from the sun. (In fact, the earth's tilt on its axis causes the seasons.)

The same thing happened with phases of the moon. Most of the people thought the phases of the moon were caused somehow by the earth getting in the way between the sun and

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Opinions expressed ... necessarily reflect positions of the ...

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the moon. That, of course, is what happens in an eclipse of the moon. (The phases of the moon have to do with the relation of the sun, earth, and moon; depending on where the moon is in its orbit, one sees more or less of its illuminated half.) So I asked the graduate students, "Well, have you ever seen the sun and the moon in the sky at the same time?" And of course, they all had, and there was another pause while they came to the realization that their theory didn't stand up.

What this little experiment shows is not a crisis in science education. In fact, this is not a science problem at all so much as it is a problem about thinking processes. All of these people knew something that contradicted the theory they were forming, but they couldn't get at that knowledge because it was in a different compartment, as it were.

We all have many private universes inside our heads, and one of the biggest problems humans have faced over time is our inability to connect these separate universes of knowledge into a coherent whole. It is an especially challenging problem now, with the rush to "technologize" education. If we don't find ways to help people learn to make connections, all the school technology we're pouring money into will wind up as no more than vocational training, with no real education attached.

The power of stories

One way of looking at the problem is to use an image created by Arthur Koestler, a great novelist who became a cognitive scientist toward the end of his life. What usually happens when we're trying to think about things, he said, is that we tend to stay within a certain belief structure. Imagine that belief structure as a level plane. We could move vertically in our thoughts, but in fact, there are powerful forces that keep us focused on the task at hand, focused on the ideas we've already had and on the way we learn those ideas. Every time a vertical thought breaks out of the plane, it usually is quashed.

But every once in a while when we're relaxed and out of the normal context of "work"—maybe in the shower, maybe just back from jogging, maybe dreaming just before dawn—suddenly one of those vertical thoughts breaks through, and we see that what we had been thinking about could be looked at in a completely different way.

Koestler calls this bisociation; educators call it nonspecific transfer. Educators know it is extremely difficult to teach children something in such a way that they will be able to apply it in a domain that is analogous to but not the same as the domain in which they learned it. Children are quite good at finding an analogy if you tell them one exists, but most of them have no inner mechanism that causes them to look for similarities and analogies, to jump out of the plane when they're thinking about something and make a connection across planes.

That presupposes other planes to connect to, of course. In other words, you have to have lots of different kinds of knowledge learned in lots of different kinds of ways in order to have something to make analogies to and cross-connections to (which is one reason general education, as opposed to vocational training, is so important). And you have to *learn* to make cross-connections, because it doesn't seem to be built in naturally to the way humans think about the world.

Instead, as the NSF experiment shows, kids are learning science and most other subjects the way people learn proverbs: It doesn't matter if one contradicts another so long as it explains the phenomenon at hand. If you come home from a trip and your significant other is glad to see you, the explanation is, "Absence makes the heart grow fonder." But if you come home and your significant other is not particularly happy to see you, the explanation is, "Out of sight, out of mind."

Oral societies want to rationalize what is happening right now, and they do it with a little story called a proverb. When one proverb contradicts another, it doesn't matter—just as it doesn't matter that the movie you liked last night contradicts the movie you liked last week. The important thing about stories is how good they are right now. Stories happen in the here and now; they create their own environment. Even when they purport to be about general knowledge, what really matters is how well they satisfy the listener.

Most of us, including scientists, learn best through stories. We are wired to learn this way because, for hundreds of thousands of years, the most important ideas of our culture have been passed along through stories. In fact, cognitive psychologists know we are predisposed to judge a statement as being more true if it rhymes.

Other ways of thinking

Over the last thousand years, however, other ways of thinking have been invented. One is mathematics. Although other ancient cultures had ways of numbering things and thinking about patterns, it was the Greeks who took an unfocused, unstructured discipline and turned it into a separate way of thinking. One of the most important things about the Greek invention of mathematics was that it was not simply about demonstration: It also involved contradiction and argument.

More recently, beginning in the 17th century, a third way of thinking evolved in sci-

WE ALL HAVE MANY PRIVATE UNIVERSES INSIDE OUR HEADS. THE PROBLEM IS OUR INABILITY TO CONNECT THEM INTO A COHERENT WHOLE.

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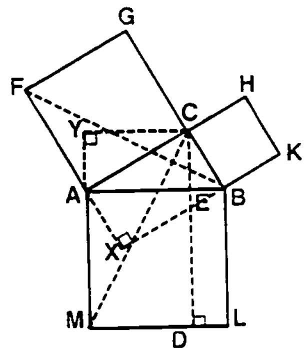
ence and politics, one that can be called ecological thinking or systems-level thinking.

Our country was built on these new ways of thought. Consider Thomas Paine's pamphlet "Common Sense," a 40-page reasoned argument against monarchy that exemplifies the mathematical way of thinking. "Common Sense" had a pivotal place in the creation of our country: Instead of letting the king be law, Paine said, let us make the law be king. Paine's pamphlet changed people's minds about most of what they believed about government, paving the way for yet a new way of thinking and creating an environment in which the U.S. Constitution could be written.



GEOMETRIC PROOF OF THE PYTHAGOREAN THEOREM

Diagram by Emily Mann, an eighth-grader at Mark Twain Middle School, Fairfax County, Va.

The Constitution is not a story: It is a recipe or systems description for a complicated mechanism, an ecology with millions of not completely agreeable parts—the citizens—that will work for hundreds of years without breaking. One of the great breakthroughs in human thought was to realize that it is better to let people live as much as possible according to their own dictates. Instead of writing laws or rules about how people should live, it is better to include in the systems description a mechanism for resolving disputes and misfits between different parts of the system.

As this example suggests, many of the most important things that constitute the fabric of our civilization have nothing to do with the story form. Modern science is not a story. American politics is not a story. It did not arise from rhetoric (though politicians want to revert to rhetoric); instead, it arose from an attempt to build a rational system that would work in spite of misfits.

These are very hard ideas, and that is why they were inventions.

Writing was an invention. Our species learns how to talk spontaneously—that's wired into us—but many cultures have never had a writing system. Printing was an invention. Mathematics was an invention. Democratic concepts such as fairness and justice, which we think of as the cornerstones of our civilization, were inventions. Every one of them is hard to learn, or they would not have had to be invented.

We can learn many things as children in a village culture. We can learn how to live our lives successfully. We can learn what the culture believes. We can learn how to hunt and fish and farm. We can learn a lot of things simply by watching others. But school was invented so people could learn the hard things, the things we don't learn naturally. School was invented so we could learn the created things that actually require us to change what's inside our heads, to learn what Seymour Papert calls powerful ideas.

And if that's the case, we should be thinking about technology as more than an aid to education. We should be thinking about something much stronger than that. Let me suggest a couple of ideas.

Triangles and bacteria

At the dawn of the invention of mathematics, Pythagoras and his followers found an interesting relationship by looking at a right triangle surrounded by the squares of its sides: If you draw three more triangles around the C square, it is easy to rearrange them so you can fit the A square and the B square and the four triangles into that larger square. That is, the sum of the areas of the squares drawn on the two legs is equal to the area of the square drawn on the hypotenuse. (See the figure.) This beautiful proof is what is called a preliterate proof—a highly satisfying, easy to understand demonstration, and definitely the proof children should be exposed to.

But shortly thereafter, someone used Pythagoras' theorem to come up with the astounding fact that no matter what system of measurement you use for the sides, that system of measurement will not measure the hypotenuse of some triangles exactly. In mathematical terms, we would say that there is no fraction n/m that will give you the exact length of the hypotenuse. This is not a proof that can be demonstrated; this proof must be done by contradiction and by argument.

It is said that the person who first came up with this proof was drowned because he had completely overturned the contemporary concept of rational thought. The Greeks did not go beyond "rational" numbers—that is, numbers that can be expressed as the ratio of two integers—and this proof introduced irrational numbers. (A stronger proof shows that if the square root of a number is not an integer—the square root of 4 is 2, the square root of 9 is 3, but the square root of 6 or 7 or 8 is not an integer—then it is also not a fraction, and that is true for all numbers.) You might think that with all the fractions that exist between each integer, you would be able to find the fractional number for, say, the square root of 6, but you simply cannot.

This branch of Greek mathematics, then, went a short way and ran into an intractable problem. That, I believe, is one reason the Greeks went on to become more interested in geometry than in algebra. They might have drowned the person who devised this proof, but they weren't able to drown the idea.

Now, let's turn from mathematics to biology. Consider a single bacterium like the millions we have inside us. The bacterium contains about a hundred gigabytes of information processing, about the equivalent of 50,000 desktop computers of a few years ago. Now consider that this bacterium is only about 1/500th the size of the cells that make up our body tissue, so within each cell is the equivalent of about 25 million desktop computers—about one-quarter of all the computers on the Internet. And we have between 10 trillion and 100 trillion of these cells in our bodies

The real shocker is that not a single atom in your body has been there for longer than seven years. In fact, about 90 percent of the atoms in your body are recycled every couple of weeks. For example, no red blood cells that are in your body now are more than 100 days old. As biological organisms, we are simply patterns that organize energy and matter into forms that look like us. We give off energy and matter so that the organizational pattern that is us moves along through time and space, but none of the atoms or the energy that we had seven years ago go with us. Millions of cells in our body are dying every day, but billions of things are going more right than wrong, and that's why we are able to exist longer.

These new ways of thinking are not just interesting from

the scientific standpoint; they also have to do with understanding how complicated organizations, such as companies, countries, and school districts, operate. Science and math, in other words, are not just about the seasons of the year and the Pythagorean Theorem. They are about something much more interesting and much more important, and that is how we think about the world. As Danish physicist Niels Bohr put it, "Science is not there to tell us about the world; science is there to tell us about how we can talk about the world."

The uses of technology

So what, after all, are computers good for? First come a class of uses I call red herrings. For example, computers can imitate in a nicer way old structures for representing things, like paper, which gives us word processors. And with spreadsheets, computers can carry out the kinds of calculations we've done in accounting systems over the last several hundred years. Computers can also be connected in networks, giving us the equivalent of libraries.

All of these uses, I believe, represent a desire on the part of a future-shocked public to see a new technology only as a better version of an old one. This happens all the time: Thomas A. Edison invented the motion picture camera in 1895, but it took 20 years before anybody realized you could move the camera while you were filming or that you could cut and splice the film and create montages.

The same thing was true with printing. In the early years of the printing press, the Catholic Church did not think to suppress it because it seemed to be doing a good job of automating what the monks had been toiling for many years to do—producing religious texts. But within 50 to 75 years, the church was under attack by ideas spread through the printed word. First came Erasmus and Martin Luther, then Copernicus, Galileo, Kepler, Hobbes, and Newton. All of a sudden the entire world was different. The Catholic Church was no longer a temporal power; nationalism arose, and something even more striking than nationalism began to emerge: the urge toward different forms of government constructed on arguments transmitted by the press.

As we look into the future of education, we should bear two things strongly in mind. First, the computer will not always be used as it is used today, which is as a paper imitator. At some point in the future, everything we're trying to teach kids about computing today in most schools will be totally obsolete. In fact, I think it's obsolete right now, because the urge to computerize schools is 99 percent vocational and only 1 percent educational. How else can we explain such graduation requirements as being able to use a word processor or a spreadsheet?

Think about what literacy actually is. Literacy begins with *ideas*, and literature evolved as a way of communicating those ideas. Computer literacy, by extension, cannot possibly be about learning how to put a disk in a machine, and it cannot possibly be about learning a spreadsheet.

THE MOST POWERFUL WEAPON WE HAVE FOR EXPLORING THIS NEW FUTURE IS THE ONE BETWEEN OUR EARS.

Computers are really for helping us understand systems that are too complicated to think about in classical ways, such as political systems or the AIDS epidemic. They are really for letting children build models of complicated ideas and understand these powerful ideas in a direct way at a much earlier age than they would have without the aid of the computer.

About 30 years ago, when we were first starting to think about how computers and education might go together, we noticed that students were not learning calculus very well. Traditionally, calculus is taught in high school in a classical form that relies on algebra. We computer people knew there was a direct way of teaching the powerful ideas of calculus to fifth-graders by using Seymour Papert's Logo Turtle program, but schools weren't using this approach. Despite many compelling presentations and demonstrations of Logo, elementary school teachers had little or no idea what calculus was or how to go about teaching real mathematics to children in a way that illuminates how we think about mathematics and how mathematics relates to the real world.

These are important issues—not because we want children necessarily to become mathematicians or scientists, but because clear thinkers understand that they cannot know everything, that they must scaffold knowledge in many different ways to put it in a representational form that can be transmitted to others. And the computer can help do that. With computers, children can play with and understand complicated structures at a young age.

It won't happen immediately, though. Over the next few years, the urge for access will dominate everything else in school technology. The push to connect schools to the information highway is taking precedence over the question of content. Most of the important ideas in our civilization are not on the Internet yet, but they are already available in free public libraries. The haves and have-nots during these coming years will not be the people who do or do not have access to the Internet. The real gap will be between those who are discerning about the information they access and those who are not—between those who use technology to help them understand powerful ideas and those who do not.

If all we do is connect schools to the Internet without considering the kinds of thinking processes students need in order to learn from the information they access, we are fooling ourselves. All the technology we put in schools is no more than the emperor's new clothes unless we attend to the content we want children to learn with the technology and the kinds of thinking we want them to be capable of at various ages. After all, the most powerful weapon we have for exploring this new future is the one between our ears—providing it's loaded. ■

Creating the Information Age School

Six schools that demonstrate the characteristics of an Information Age school provide insights into what educators must do to give students the skills they need to succeed in the workplace and the community.

Most school-age children in the United States interact every day with a variety of information media—television, video games, multimedia computer systems, audio- and videotape, compact discs, and print. At the same time, workplaces are retooling with advanced technologies and acquiring access to complex, comprehensive information systems to streamline operations. Our youth have so much exposure to technological gadgets and information resources that one would think the transition from school to workplace would be second nature. Not so. According to recent projections, only about 22 percent of people currently entering the labor market possess the technology skills that will be required for 60 percent of new jobs in the year 2000 (Zuckerman 1994).

To eliminate this mismatch between schools and workplace, we need "Information Age" schools. But what does an Information Age school look like, and how do you begin to create such a school?

What It Looks Like

Researchers (Breivik and Senn 1994, Glennan and Melmed 1996, Cuban 1997) point to at least six attributes that characterize an Information Age school. The following descriptions of these attributes include examples of exemplary schools, along with contact information. I have "found" each of the schools by making site visits in my former role as an ASCD regional director and by serving as a judge in a variety of technology competitions.

Interactivity. In schools demonstrating interactivity, students communicate with other students through formal presentations, cooperative learning activities, and informal dialogue. Students and teachers talk to one another about their learning tasks in large groups, small groups, and one-to-one. Students have constant access to and know how to use print and electronic information resources to inform their learning activities. They recognize the value of the information in their own communities and interact with various community members, including businesspeople, social service staff, arts professionals, athletes, older adults, and volunteer workers, enhancing their curriculum studies with authentic information from primary sources.

At the Sun Valley Elementary School in Winnipeg, Manitoba, 4th grade students regularly participate in "keypals" activities to exchange cultural information with schools around the world. Students in grades 5 and 6 use resources from their school and community to develop "talking books" that provide graphic, textual, and auditory lessons on animals, foods, weather, and other classroom topics for the 1st grade class. The librarymedia specialist helps students develop interactive multimedia projects for their classes and the community. One such project takes citizens on an adventure tour of Winnipeg.

The most probing questions come from the learners, who are curious about a variety of issues and intent on communicating what they discover.

Contact: Sun Valley Elementary School, 125 Sun Valley Dr., Winnipeg, Manitoba R2G 2W4, Canada; (204) 663-7664.

Self-initiated learning. When students initiate their own learning, they participate in productive questioning, probing for information they can use rather than waiting for the next question on a test or from a teacher. Information resources are central, not peripheral, in day-to-day learning activities. Students gather their own data to learn about topics, using a variety of sources and practicing effective research techniques. They are able to examine the large quantity of information they have gathered, synthesize it, and reduce it to usable quantities for their purposes. They can analyze and interpret information in the context of the problems or questions they have identified, and they can evaluate not only the quality of the information they've gathered but also the processes they've used to gather it.

The most important role for information technology at Taylorsville Elementary School in Taylorsville, Indiana, is to support a commitment to self-paced, individualized learning. Students participate in a program that emphasizes high expectations in core subjects and allows them to work at their own pace. Teachers use instructional strategies like multiage, multiyear groupings and team-based project work. Teachers facilitate, rather than direct, student learning, and they are comfortable using a variety of information technologies. Two days each school year are devoted to ongoing technology training, and a technology coordinator and three part-time aides assist teachers with their technology-related problem solving.

Contact: Taylorsville Elementary School, 9711 Walnut St., Taylorsville, IN 47280; (812) 526-5448.

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A changing role for teachers. To develop self-initiated learners in the Information Age school, the teacher's role must evolve away from dispenser of prefabricated facts to coach and guide. In this continuously changing role, teachers leave fact-finding to the computer, spending their time doing what they were meant to do as content experts: arousing curiosity, asking the right questions at the right time, and stimulating debate and serious discussion around engaging topics. In fact, every adult in the school community communicates the power of knowledge by modeling a love of learning. Preservice and inservice programs require the use of information resources and technologies as an integrated part of teachers' certification and recertification. Teachers create a community among themselves in which they are willing to plan together, share successes, resolve challenges, and model strategies for one another.

Professional development in information technologies is available daily at Adlai Stevenson High School in Lincolnshire, Illinois, in a specialized lab for teachers staffed by a full-time trainer. Proficiency with technology resources is a hiring requirement for teachers. All teaching staff have a three-year period to demonstrate proficiency with voice, data, and video technologies. The rigor of staff training reflects the school's commitment to providing students with an environment that promotes lifelong learning, provides opportunities to access global information and create knowledge, encourages participation from the community, and develops the skills of collaborative problem solving. Teachers and students use information technologies constantly for instruction, assessment, exploration, management, and the school's day-to-day operation.

Contact: Adlai Stevenson High School, One Stevenson Dr.,

Lincolnshire, IL 60069; (847) 634-4000; Internet: http://www.district125.k12.il.us.

Media and technology specialists as central participants. Media and technology specialists are critical in the Information Age school, and their role is twofold. Working with students, they are project facilitators. They can ask the initial questions that help students develop a focus for inquiry. They are thoroughly familiar with the school's and district's information resources and can direct students to multidisciplinary materials suitable for their investigations. With their technology skills, they can expose students to resources in a variety of media as well. They can assist students in their efforts to develop technology-enhanced products and presentations.

Working with teachers, they are instructional designers—partners in curriculum development and unit planning. Their expertise with information resources can inform teachers' exploration of curriculum topics and assist them in locating the materials they need. And, because ongoing professional development is an integral part of the work in an Information Age school, media and technology specialists contribute their expertise to the design and delivery of technology-enhanced inservice programs.

Traditionally, students learned information skills in isolation as part of elementary- and middle-level "library skills" development. Technology "literacy" programs took place in computer labs during pull-out programs or in separately scheduled classes. In the Information Age school, such skills are taught on an as-needed basis, and they are integrated throughout the curriculum.

As a result of a districtwide effort to reform curriculum and instruction, the school day at Christopher Columbus Middle School in Union City, New Jersey, is organized into blocks of 90 minutes to two hours. Longer class periods have allowed teachers to create a project-focused, research-based curriculum that integrates the traditional subject areas with access to local and remote information resources through a variety of technologies. In addition to a central computer lab for whole-class instruction and walk-in use, each of the school's 12 classrooms has five computers, a printer, and a video presentation station. Students also have access to multimedia production equipment, computer video editing capabilities, and Internet connectivity from all PCs. Teachers receive three days of paid technology training each year, and a full-time technology coordinator conducts student computer classes, consults with teachers, and handles troubleshooting.

Contact: Christopher Columbus Middle School, 1500 New York Ave., Union City, NJ 07087; (201) 271-2085.

In the Information Age school, information skills are taught on an as-needed basis, and they are integrated throughout the curriculum.

Continuous evaluation. Everyone in the Information Age school recognizes the need for continuous evaluation not limited to scheduled standardized assessments. They engage in a high level of introspection, asking questions about the appropriateness of information resources, the efficiency of information searches, and the quality of information selection and evaluation. They also examine the quality of the products and presentations they use to share the results of their inquiries, as well as the communication process itself.

The Maryland Virtual High School of Science and Mathematics is a collaboration of 15 schools. They use information technologies to focus on computational science studies, accessing the Internet for mentoring, sharing projects, and assessing science resources. Students and teachers search and communicate online through local area networks (LANs) attached to each school's Internet hub. They use various software applications to create computational models of processes such as climate phenomena, animal population changes, and planetary motion. Teachers from the participating schools attend several three-day professional development sessions each year, as well as a five-day workshop at the end of each school year. Project staff are available for schoolwide training and outreach efforts in the various school communities.

Contact: Maryland Virtual High School of Science and Mathematics, 313 Wayne Ave., Silver Spring, MD 20901; (301) 650-6600; Internet: http://www.mbhs.edu.

A changed environment. An Information Age school has a different look and feel than a traditional school. Classroom methods link information retrieval, analysis, and application with strategies such as cooperative learning, guided inquiry, and thematic teaching. Information technologies are easily accessible, not locked away in media closets or labs. Student projects and products proliferate—not just as display items but as resources for other students and information for future investigations. Classrooms and hallways are frequently the scene of discussions and debates about substantive issues—topics important to both the curriculum and to the students investigating them. Most important, the most probing questions come from the learners, who are curious about a variety of issues and intent on communicating what they discover: How do you know that? What evidence do you have for that? Who says? How can we find out?

The curriculum at Patton Junior High School in Fort Leavenworth, Kansas, is "driven by students' needs to be productive members of an ever-advancing Information Age" (U.S.D. 207 Technology Initiatives brochure 1996). Instruction reflects the district's efforts to maintain high standards of achievement while encouraging learners to investigate a variety of topics in an exploratory environment. Students use technology tools and develop life skills in a 26-module program that includes topics such as robotics, audio broadcasting, maintaining a healthy heart, and becoming a confident consumer. The media center and classroom computers all provide Internet access. Teachers can use a centralized media management system to remotely schedule videotape, laserdisc, and interactive CD presentations without the need to check out and transport bulky equipment.

Contact: Patton Junior High School, 5 Grant Ave., Fort Leavenworth, KS 66027; (913) 651-7373; Internet: http://www.ftlvn.k12.ks.us.

How to Begin

To transform your school into an Information Age school, begin by using information technologies to encourage experimentation with the school's program. Focus on improving the connections between curriculum content and school process. Lengthen class periods. Consider multiage grouping. Experiment with interdisciplinary, problem-based, or thematic approaches to instruction. Develop individualized instructional plans for every student. Implement ongoing assessment measures that reflect students' continuous learning (portfolios, projects, performances). Encourage community members to regularly contribute their time and expertise throughout the school. Include them as part of decision-making groups for curriculum and technology planning. Provide incentives to teachers and administrators who demonstrate their willingness to try new methods and share what they've learned with their peers. Hire technology support staff with teaching experience to consult with teachers as well as troubleshoot equipment. Pay teachers to participate in professional development activities.

Rather than sitting back (like passive television viewers) marveling at the ever-increasing quantity of information and the rapidity of change, educators must lead students through a careful, cumulative acquisition of information literacy and technology skills. Teams of school professionals can plan integrated activities focusing on important content while encouraging students to practice these skills. Learners should engage from their earliest years in rich, complex, authentic experiences that provide a tension between creativity and utility. These experiences should also offer frequent opportunities for feedback and an environment of trust and open communication. This "orchestrated immersion" (Palmisano et al. 1993) can help ensure that students will leave their school years better prepared to participate actively and flexibly in their communities and the workplace. ■

References

Breivik, P., and J. Senn. (1994). *Information Literacy: Educating Children for the 21st Century*. New York, N.Y.: Scholastic.

Cuban, L. (May 21, 1997). "High-Tech Schools and Low-Tech Teaching," *Education Week on the Web* (http://www.edweek.org/ew/current/34cuban.h16).

Glennan, T., and A. Melmed. (1996). *Fostering the Use of Educational Technology: Elements of a National Strategy*. Santa Monica, Calif.: RAND.

Palmisano, M., M. Barron, and L. Torp. (1993). *Integrative Learning System: Rationale, Overview, and Reflections*. Aurora, Ill.: Illinois Mathematics and Science Academy.

Unified School District 207. (1996). "Patton Junior High School Technology Initiatives." (Pamphlet). Ft. Leavenworth, Kan.: Author.

Zuckerman, P. (July 18, 1994). "America's Silent Revolution." *U.S. News and World Report* 117, 3:90.

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Sheldon Berman and Robert Tinker

The World's the Limit in the Virtual High School

Combining high-quality instruction and current technology, netcourses in virtual high schools are uniquely able to reach specialized groups of learners—any time and any place.

The instructional potential of the Internet is extraordinary. Yet schools have hardly scratched its surface. With the assistance of a five-year U.S. Department of Education Technology Innovation Challenge Grant, the Hudson (Massachusetts) Public Schools, the Concord Consortium Educational Technology Lab, and 30 collaborating high schools across the nation have begun a bold and far-reaching experiment to realize this potential through the development of a virtual high school over the Internet. Through Internet-based courses, Virtual High School significantly enhances the curricular offerings of each school and integrates the best that technology can offer into the academic curriculum.

Netcourses bring the world into schools by tapping into knowledge and experience anywhere.

Virtual High School is built on a simple concept. Each school in the collaborative selects one or two innovative and technologically adept faculty members to teach over the Internet. These teachers receive training in how to teach netcourses, engage students, maximize the use of Internet-based resources, and utilize the best in multimedia technology. In exchange for releasing each teacher to teach one netcourse, the school is able to register 20 students to take netcourses offered by any of the participating schools. Because the teachers for these 20 students may be in 20 different schools, each school provides release time for a site coordinator who acts as a guidance counselor and technical advisor for students in that school who are taking netcourses.

In the future, our university and corporate partners will also offer courses, at times even for university credit. In this way, we bring the world into schools by tapping the knowledge and experience of corporations, universities, and individuals anywhere. This instructional medium is particularly effective for four types of courses:

1. Advanced courses, including advanced placement courses: advanced electives such as "Modeling and Calculus:" or advanced literature courses in any language.
2. Innovative core academic courses that maximize the use of technology, such as "Writing Through Hypertext," a simulations course on "Economics and the Budget Debate." or the "Global Lab" environmental studies course that uses online collaboration among students worldwide.
3. Courses for language minorities. so that small groups of students from a particular language background for whom individual schools are not able to offer a bilingual program can take courses in their native language.
4. Technical courses built around the very technology we are using, such as "Network Operations" and "Robotics."

In September 1997, Virtual High School teachers began offering 29 courses to more than 550 students from 27 high schools. The initial set of courses includes such titles as "Microbiology," "Model United Nations," "Informal Geometry," "Writing through Hypertext," "Business in the 21st Century," "Stellar Astronomy," "Bioethics," "Advanced Placement Statistics," "Economics and the Budget Debate," "Poetics and Poetry for Publications," "Programming in C++," and "Music Composition."

Virtual Classes, Real Benefits

Virtual High School provides four unique benefits for schools and students. First, it significantly expands curricular offerings. For example, many high schools cannot offer advanced or specialized courses because enrollment is too low to economically justify the course. Through netcourses, however, small groups of students at a number of high schools can fill these courses.

Second, it provides technology-rich instruction. Netcourses give students experience in telecollaboration and the use of software tools in the context of serious academic instruction. Netcourses provide learners experience with e-mail, online working groups, and online conferencing. They challenge students to learn how to use the medium to communicate well.

present data authoritatively, and demonstrate effective research skills.

Third, Virtual High School brings unprecedented resources to schools. Students learn how to access the wealth of data on the Internet. From exploring primary source material at the Library of Congress to accessing scientific databases to conversing with experts, students can take their learning far beyond textbooks into the real world of open-ended problems and unanswered questions.

Finally, Virtual High School significantly enhances teachers' skills in technology that can extend to their regular classroom instruction. There is probably no better way for teachers to become adept at telecollaboration and using a wide range of software tools than to make daily use of them in their instruction.

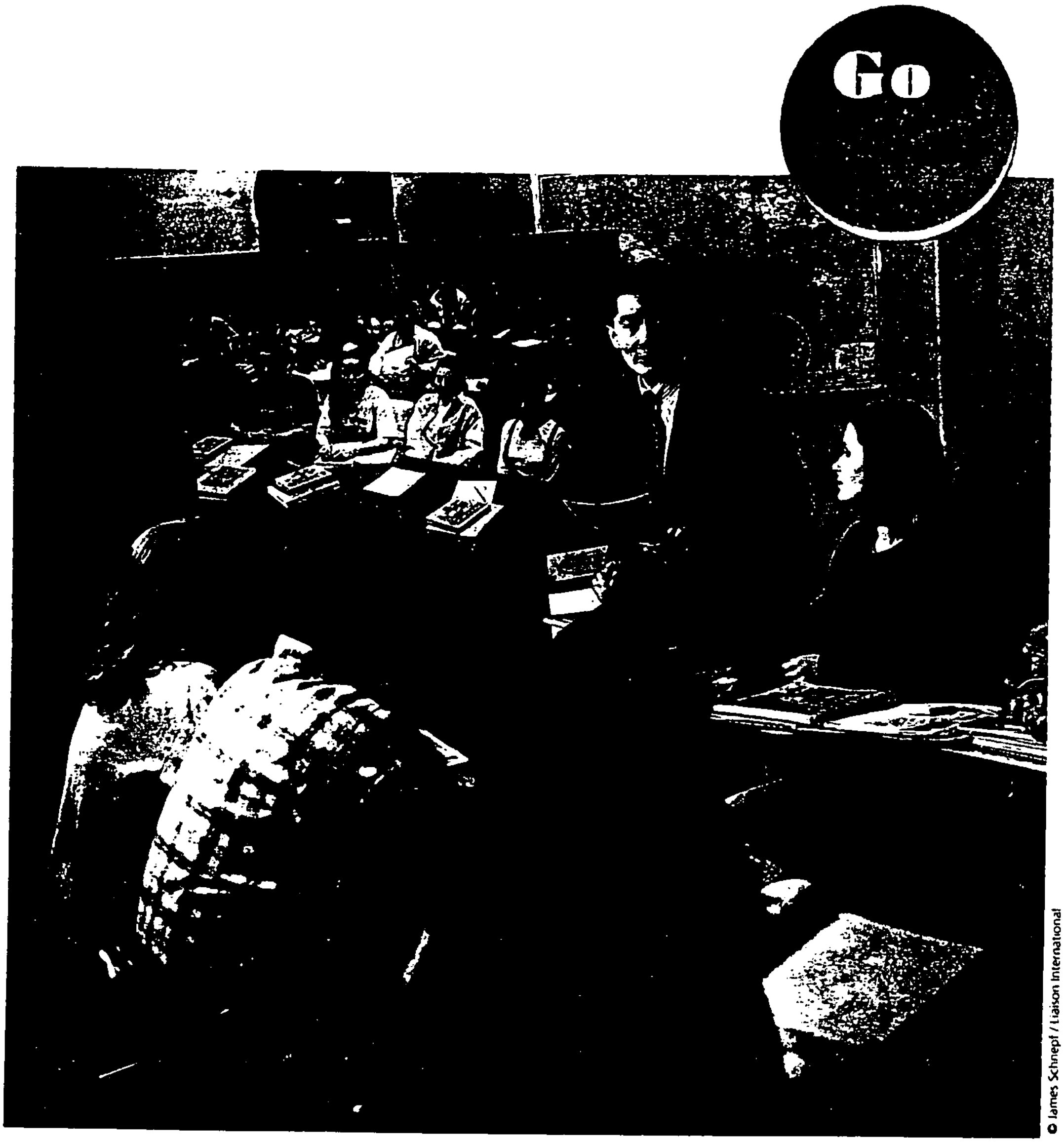
New Approaches to Instruction

Although netcourses provide unique benefits for education, they are a challenge to organize and teach. Netcourse instruction is different from regular classroom instruction and requires a particular approach to be successful. One cannot simply transfer a traditional course into the Internet environment. A number of netcourse design characteristics that match technology and quality education have emerged:

Asynchronous communication. Netcourses need to make effective use of asynchronous communication that does not require the sender and receiver to be present at the same time. These asynchronous technologies include electronic mail, conferencing, and news groups. Synchronous technologies, such as two-way voice and video, real-time chats, and shared applications, require two or more users to be present at the same time. Asynchronous communication is more adaptable to a person's schedule, works far better across time zones, and usually requires less technology.

Seminar model. Many teachers who experiment with online courses report being overwhelmed with enrollments of only 10 or 12 students because they set up e-mail conversations with each student. The better model is more like a seminar, in which the teacher determines the topic and activities, encourages substantive interactions among students, monitors and shapes the conversation, and promotes an atmosphere in which students respond to one another's work. This model results in more conversation, is far more likely to be constructivist, and builds on the rich learning that takes place in groups.

Technology-rich instruction. Access to the Internet and multimedia computing is a requirement for netcourses. Participants need to utilize all the resources of the Internet—data, images, references, current events, and expertise. Because of the general isolation that a student taking a netcourse may experience, a text-based course will not hold interest. Teachers need to use all available technology resources—including digitized images, short audio and video clips, graphics, conferencing, and multimedia presentations—to bring students in contact with one another



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and the reference world within the network.

Project-based learning. In addition to maximizing the use of technology to engage students, netcourses need to create forms of instruction that actively involve students. Projects that are posted for the whole class, simulations and gaming that involve the class in role-playing, and collaborative investigations are strategies that provide the kind of hands-on engagement that breaks away from the static medium of text-based communication.

Netcourses have some obvious disadvantages as well, the most significant being the lack of face-to-face communication. Interpersonal communication is far richer than electronic communication. Responses are immediate, nonverbal cues enhance communication, and group dynamics become an important part of the message.

The lack of this kind of communication, however, may serve some students well. Often in classrooms, the social dynamics of the group dictates who responds and who is acknowledged.

In the rapid-fire exchanges of the classroom, those who think the most quickly are often the most vocal. A netcourse brings freedom from these restraints. Virtual High School students enter a new social environment that does not carry their personal history into each course. It gives students the time to think through an answer and shifts attention from articulate speech to articulate writing and presentation. Netcourses offer opportunities for students to demonstrate unique abilities that they may have not been able to exhibit in the regular classroom.

Photo courtesy of the U.S. Department of Education

Sheldon Berman shows U.S. Secretary of Education Richard Riley and Congressman Marty Meehan (Mass.) how to enter the Virtual High School.

Freedom from Time and Place

Netcourses have a number of built-in advantages compared to traditional courses. The asynchronous communication can be more inclusive than classroom discussions, the seminar model provides for stronger collaborations, and the full use of information technologies gives teachers and students facility in their application.

But one of the greatest advantages is that netcourses can be offered any time and any place. Thus they can reach new audiences, utilize new teachers, and tailor instruction. Homeschooled students, students who are too ill to attend school, and students who live in rural communities can have the same rich curriculum as anyone else. A netcourse faculty can easily be a world-wide team of experts, as netcourses make it feasible for far more people to share their time and knowledge with interested learners. Because netcourses have a global reach, teachers can tailor them to serve learners, from special needs students to language-minority students to students interested in a highly specialized topic. The ability to use new kinds of teachers to reach new, widely scattered and specialized audiences means that netcourses can have an impact both within the traditional structure of the high school and far beyond that structure as well.

Netcourse instruction is different from regular classroom instruction. One cannot simply transfer a traditional course into the Internet environment.

Virtual High School can never replace the experience of being in a positive social learning environment within a school. Yet this project opens a new medium for education that can merge the best in instructional practice with the best in current technology. ■

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Feature

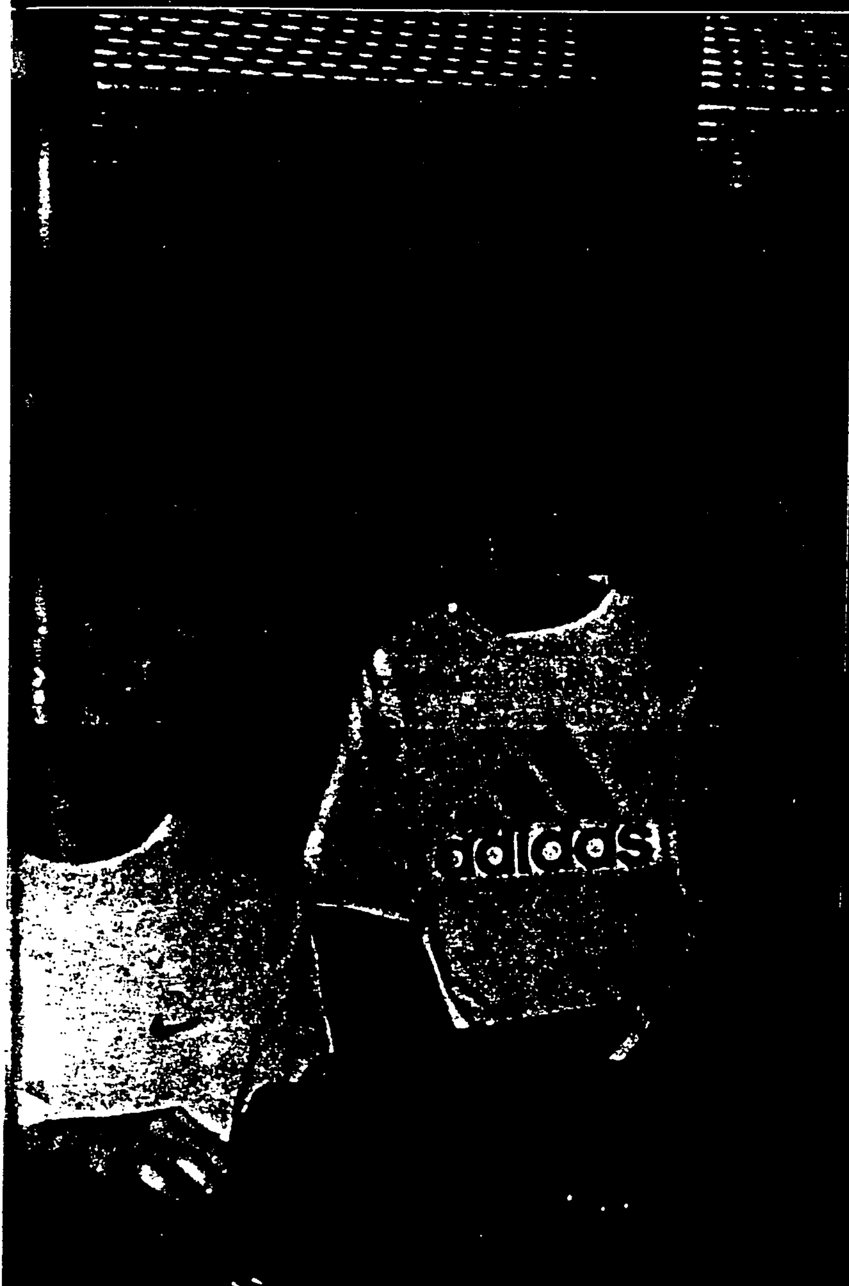
Learning All O

Integrating Laptop Computers in

By Jackie Gottfried and Melissa Gilliland McFeely

Over The Place

nto the Classroom



Laptop computers can provide students with the opportunity to learn anywhere and anytime. One school district in a rapidly growing rural area of the United States, for example, collaborated with large corporations and a private foundation to provide low-cost laptop computers to its middle school students. The two case studies in this article detail student and teacher reaction to this innovation.

A new form of technology integration—student use of laptop computers in and out of the classroom—is being modeled in schools around the world. One pilot program in Australia showed increased student achievement and motivation when all students were provided with their own laptops. Currently, Microsoft and Toshiba are helping support similar programs in the United States. In many areas, schools and school districts can afford to purchase these computers and rent or lease them to students.

Our own district in South Carolina, however, provides a model for school districts that cannot easily raise funds for this type of technology purchase. At the suggestion of our superintendent, parents and other interested community members formed a private foundation to solicit funds and purchase the computers. See "The Laptop Program" on page 12 for more information about the computer project and the Beaufort County SchoolBook Foundation.

More than 300 sixth-grade students were chosen to participate in this pilot program. Twenty-five teachers were trained to use the hardware and software and, more important, how to integrate both into their classrooms as tools rather than separate subjects. We participated in the laptop program, and the following case studies describe how we coped with the challenge of integrating the laptops into our classes and how our students reacted to the innovation.

Jackie's Story

Our school district in coastal South Carolina resumes classes in the middle of August. Sixth graders naturally come to us filled with excitement and some expected hesitancy because they are entering a new phase of their lives: They are becoming middle school students.

When we began classes in August 1996, however, another element was added to the picture at the district's three middle schools. A group of families at each school had signed up to participate in a pilot program that came to be known locally as the Beaufort County SchoolBook Project. Laptop technology was made available to sixth-grade students who wanted to be brave pioneers! Those of us who were involved in the initial phase during the 1996–97 academic year will never forget this program.

We spent the first months of the school year preparing for the arrival of our laptops. We visited the computer labs and worked on our keyboarding skills. Many of our students already had some computer skills, however. Some used PCs at home, and others had been trained in computer classes at elementary schools in the district.

We tried to help students develop a "technology vocabulary" as they worked on the desktop computers in the labs. Students used the words *Microsoft* and *Toshiba* on a daily basis. And the most-asked question of the first three months was "When are the laptops arriving?"

One day in November, the laptops arrived at our school, and all of the students who were to receive laptops ran to the windows to watch the truck being unloaded! That night the district and the foundation not only distributed the laptops, but also gave presentations, registered the machines, and discussed maintenance procedures with students, parents, teachers, and others in the SchoolBook Project. The students were bursting with enthusiasm, and it was exciting to see parents and children sitting together and becoming familiar with the new computers (see Figure 1). Teachers made a point of stressing how the laptops would be used in the academic setting. The energy level was incredibly high. We were finally ready to go!

From the next morning on, we worked on the laptops every day in all of our five classes. Children became comfortable working with Microsoft Word, Excel, and PowerPoint. Teachers often

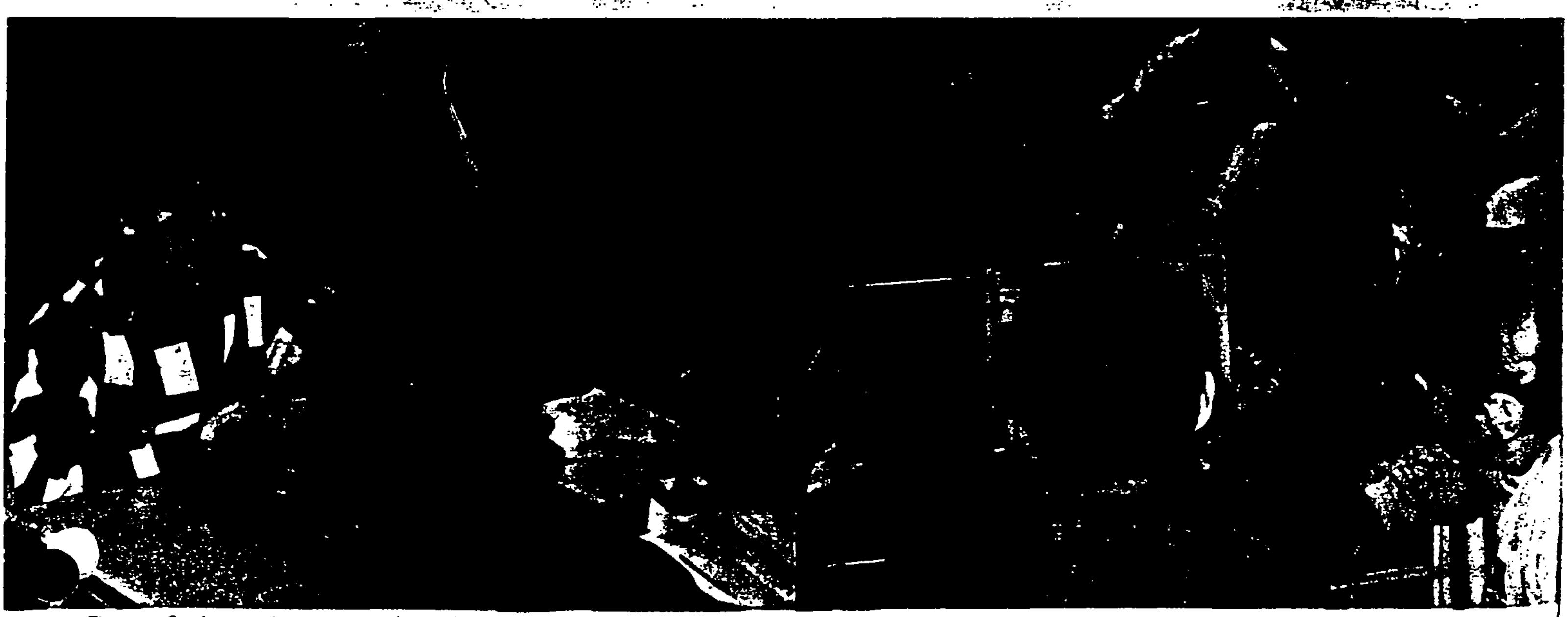


Figure 1. Students and parents get to know their new computers.

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spoke about what was going on in class so that we were all aware of the variety of assignments. We worked together on a number of activities. Students took notes in classes and saved their material on their hard drives. We used color-coded disks to denote each subject area so that we were able to select specific tasks that students were required to save on disk. Homework could be done on the laptops and then printed out during homeroom the following morning. We felt energized when we saw our students so interested in each others' work. They were eager to help one another as well as assist the teachers.

Language arts assignments lend themselves to laptops. Editing written work became a more comfortable task for many students, especially once they became more familiar with the programs and their capabilities. And students could create computer-based vocabulary lists of new words they encountered during their reading (see Figure 2). The math class constructed spreadsheets (see Figure 3) and learned ways to collect and analyze data: these skills carried over to science, especially when students prepared for the annual Science Fair. Reading and social studies topics were also interrelated and lent themselves easily to PowerPoint presentations.

Students used the outlining skills presented and practiced in language arts classes to develop themes for their presentations in other classes. For example, the social studies classes were studying ancient Greek and Roman civilizations. Based on their study of myths in language arts, students chose particular Greek or Roman myths, heroes, or historical figures to study. They created PowerPoint presentations that discussed the myths or people in relation to the two cultures. For example, one student learned about Greek architecture and proceeded to illustrate the various types of columns. Students later re-created their presentations as short essays for their language arts classes.

Students graphed, charted, recorded, illustrated, and demonstrated on many levels. The 1997 academic year ended on a high note for us all.

Melissa's Experience

"Someday every student will have a personal classroom computer," a friend remarked 10 years ago. The idea of a computer for every child seemed preposterous. I laughed and answered, "I don't think so!" Last year I found myself in that unimaginable situation.

At the end of the 1995–96 school year, our principal announced that the Beaufort County School District planned to participate in a laptop computer project with the Microsoft Corporation and Toshiba. District officials planned to begin the project with the 1996–97 class of incoming sixth graders and expand it to include more students in the following school years. Because this was to be a pilot project, only teachers with an avid interest would participate. I was fascinated. This project would place laptop computers in the hands of my students. Ideas swarmed through my mind. I could see my students using laptops to take notes, compose writing projects, and create PowerPoint presentations. I envisioned them using Excel to create charts and graphs and to manipulate data. At the end of the meeting, I rushed to my classroom and wrote a proposal requesting to be part of the project. One of the most challenging and exciting experiences of my 30-year teaching career was soon to begin.

I left school that June eager for the summer break. I left the worries of funding and obtaining laptops to the administrators. I imagined what my students and I would do with this kind of technology at our fingertips. The dream became a reality in November when more than two-thirds of my second-period English students marched proudly into class toting their laptops in sturdy, lightweight, and waterproof backpacks.

I sensed my students' enthusiasm. My own matched theirs but was mingled with anxiety. Because district personnel had anticipated some level of teacher anxiety, quality staff-development sessions were available to us throughout the school year. Initially these sessions involved practical laptop training and problem-solving strategies; later sessions were expanded to allow the sharing of ideas as well as successes and failures.

The few students who did not have laptops were one source of anxiety for me. I worried that they might feel shut out or left behind. I made it clear to them that they had unlimited access to the two classroom PCs as well as computers in the media center and computer labs. The problem resolved itself when the students worked on group projects and laptop computers were shared among group members (see Figure 4).

My anxiety lessened even more as we established basic rules and guidelines. Students agreed to set up their laptops as soon

Word	P.O.S.	Definition
void	n.	total emptiness
specter	n.	a ghost or ghostlike being
destitute	adj.	extremely poor
implored	v.	asked or begged forcefully
blemish	n.	defect or scar
misanthrope	n.	a person who hates or distrusts everyone
ponderous	adj.	very heavy; weighty
morose	adj.	gloomy; cheerless
trifle	n.	something of little value or significance

Figure 2. A vocabulary list created in Microsoft Word. Students can create such lists and add a year's worth of new words to them.

My Bank Account				
Date	Withdrawal	Deposit	Int. Credited	Balance
Oct. 18	0	17	0	17
Nov. 22	0	9	0.51	26.51
Jan. 10	0	78	0.8	105.31
Jan. 31	0		3.16	108.47
Jan. 31	0	12		120.47

Figure 3. Excel made mathematical analyses easy for students.

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Figure 4. Collaborative group work is an essential component of student laptop use. Not only do students gain essential group skills, but such work also allows students without laptops to be part of the innovation as well.

Figure 5. Students work individually on their laptops, with guidance from the teacher.

as they entered the classroom. I placed a schedule on the overhead screen every morning, and students read it to see what to bring up on their computer screens. They either used their laptops immediately or set them aside until needed. Initially, some students tried to spend class time playing games, but this problem disappeared once I enforced the rule to use laptops only for class-related work. Various student computer experts were identified early on, and they frequently helped their fellow students overcome problems. I was relieved to learn that I did not have to be the computer expert. I was free to develop my own multifaceted role in our learning-centered, interactive environment. We gradually settled into our new routine, and computers became an integral part of our daily classroom lives (see Figure 5). It was soon evident that laptop computers were not educational frills, but valuable classroom tools.

I was eager to use the laptops for dynamic projects. When we studied the short classics, PowerPoint emerged as an exciting tool. Students worked in pairs for our first project. I assigned a major character and a specific scene to each group. For instance, one group concentrated on Mary Shelley's *Frankenstein.* One student imagined Victor Frankenstein regretting his monstrous creation and apologizing for the monster's evil deeds. The other student in that group imagined herself as the monster. She wrote a diary entry revealing the monster's feelings as he reflected on his life and contemplated death. Students then presented their diary entries through PowerPoint slide shows. They also printed hard copies of the diary entries and drew illustrations to accompany them. These hard copies and illustrations made an exciting bulletin board display.

Near the end of the year, we planned "An Evening of Classic Literature" performance for parents. Students divided into groups, and each group chose a classic for its project. Some groups chose Shakespearean plays, while others chose novels such as Henry James's *Turn of the Screw*, epic poems such as Homer's *Odyssey*, or short stories such as Edgar Allen Poe's *Tell-Tale Heart*. Each group selected a favorite scene from its story or play and typed a script based on that particular scene. They used PowerPoint to compose synopses of the plays and novels. Figure 6 shows two student-created PowerPoint slides. Parents enjoyed watching students present their slide shows and reenact scenes from the classics.

These projects were exciting, but the practical daily use of laptops in the classroom made them indispensable. Some students chose to do homework on the laptops, while others used pencil and paper. I collected paper-based homework from some students while others brought their assignments up on their computer screens. I walked around the room, gradebook in hand, scanning computer-generated homework. These students seldom handed in hard copies, and they had the added benefit of being able to correct mistakes while I briefly conferred with them. Many students kept vocabulary notebooks on disk. If the daily schedule included vocabulary introduction or review, they had their disks ready and used their laptops instead of pencil and paper. Students were permitted to use their laptops for all written responses, such as chapter summaries, end-of-chapter questions, character sketches, essays, or creative writing assign-

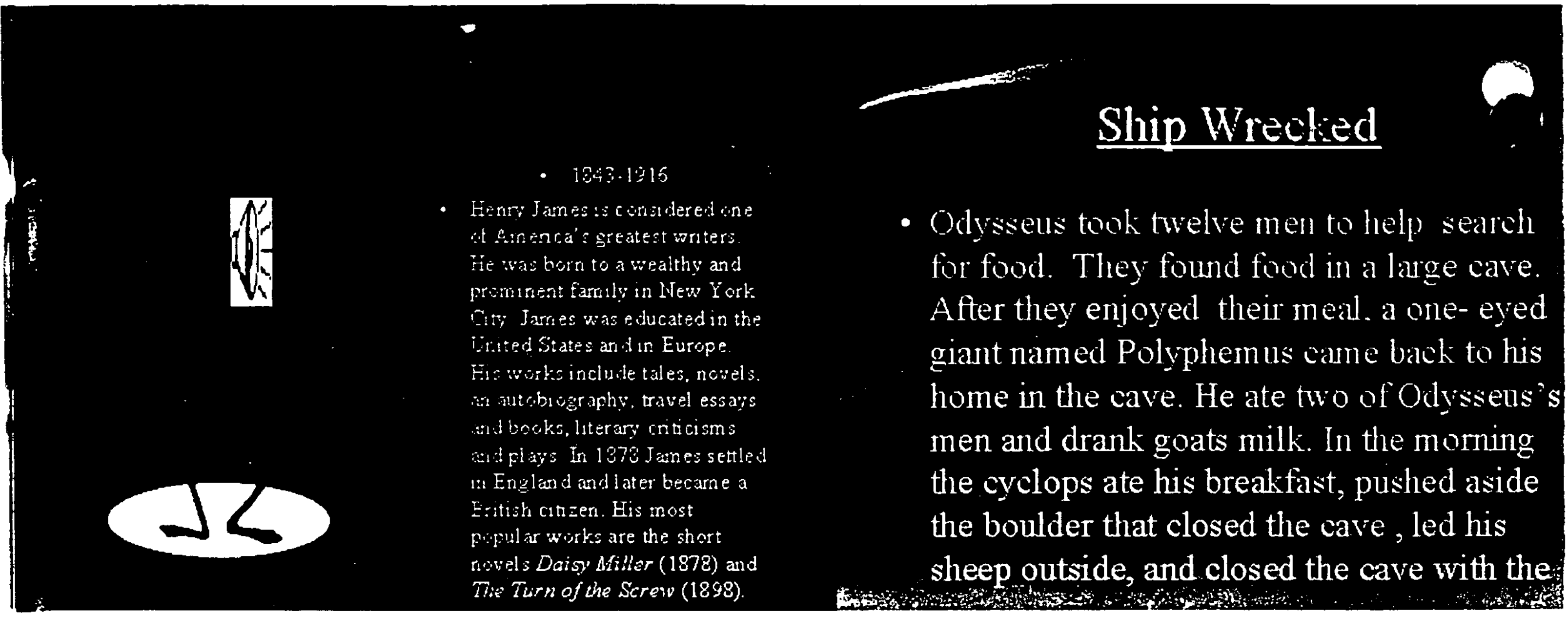

Figure 6. Students presented PowerPoint slideshows that gave plot synopses of these and other stories, and they acted out scenes from the stories at "An Evening of Classic Literature."

ments. They routinely saved their work to disk. If we needed to verify, recheck, or print an extra hard copy of a document, it was available on the student's hard drive and floppy disk.

We entered lots of essay contests. Students followed our school's standard writing process. They used their laptops for each step of the process, beginning with initial brainstorming and ending with a final hard copy. I constantly moved around the room conferring and advising as they worked. We proofread, edited, and revised daily. Peer and teacher editing was much easier using the laptops. We didn't have to waste time deciphering messy handwriting and sloppy handwritten revisions. Changes could be made easily and neatly. Students rarely printed out hard copies of rough drafts. The editing and revising processes were ongoing and usually resulted in highly polished final copies.

Final Thoughts

We experienced quite a whirlwind that year. We faced many questions each day, some of which we could not answer. We began to work together more closely, and we also began to rely on technology teachers and media specialists for technical assistance.

We both believe that the SchoolBook Project enriches and enhances our students' academic lives. Student motivation is extremely high—they exhibit excitement from the first day they spend using laptops.

Teachers' roles in technology-rich classrooms can be flexible and interactive—and change constantly. Teachers may start out acting solely as instructors, giving students the required information for their assignments. But then they must quickly switch to other roles, such as facilitators, passive managers, and active managers.

We and the other teachers involved in the SchoolBook Project generally agree that technology use has not cured *all* of the problems and challenges we face, but we didn't expect it to. All of us want to continue to be involved in this program. We cannot imagine teaching our classes without the laptop computers.

Many resources are available to classroom teachers interested in starting this type of program in their school or district. To see two of them, go to the Microsoft Anytime Anywhere Learning Web page at http://www.microsoft.com/education/k12/aal or the Toshiba Education Programs Web page at http://education.toshiba.com. ■

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Note: Melissa McFeely has collaborated with Pam Kinsey, also a teacher at Robert Smalls Middle School, to create training sessions and materials for both teachers and students. Melissa and Pam have trained teachers and students at their school to use laptop and desktop computers. They are interested in conducting training sessions at other schools and districts. Please contact Melissa at the address above for more information.

The Laptop Program

In response to an invitation from the school district superintendent, a group of community volunteers in Beaufort County, South Carolina, formed the Beaufort County SchoolBook Foundation to help offset the costs of providing laptops to all students. The foundation negotiated a leasing program that would require a minimal monthly contribution from parents. The total monthly payment was $57, of which the foundation covered $22 (or more for students eligible for reduced or free lunch programs). The foundation raised money to cover its portion of the leases from local businesses, other community groups, churches, and individuals. The foundation also created a Web page (**http://www.hhisland.com/learning/schoolbk/index.html**), a particularly innovative and low-cost method of spreading the word about the project and of soliciting donations. The page contains links to information about the project and its costs, an online pledge form, and details about the Adopt-a-Kid program.

Anytime Anywhere Learning Project

In 1996–97 and continuing this school year, 52 schools representing 10,000 teachers and students in grades 4 through 12 are participating in a project that provides them with access to laptop computers 24 hours a day. The project is supported by Microsoft and Toshiba; both companies are also funding a two-year independent evaluation that will measure the effects on teaching and learning of student use of full-featured laptops.

Microsoft offers a resource book and Web site to provide schools with ideas, best practices, strategies, models, and case studies as well as connections to potential solutions for hardware, financing, insurance, and training. Toshiba works more directly with the schools to provide hardware, financing, and insurance solutions.

Implementation of laptops is not the product of one model or blueprint. Each school system developed its own model. Both public and private schools funded their laptop programs through a variety of sources, including reallocation of school budgets, parental contributions, corporate and community sponsorships, and government grants.

PHOTO COURTESY OF MICROSOFT CORPORATION.

What Kind of Jobs? *What Kind of* Skills?

To be literate in our changing world requires a vocabulary of symbols, images, and cues.

For many years, American business got what it wanted from schools: people suited to work in factories. Over the past two decades, however, business has changed drastically from an industrial to an information orientation, with fierce global competition. Today, a skilled, thinking workforce is key to competitive success.

James R. Houghton, retired chairman of Corning Incorporated and chairman of the U.S. Labor Department's National Skills Standards Board, credits the work of economist Lester Thurow with identifying fundamental workplace changes. He points out that, in the past, companies and nations prospered if they enjoyed one or more of four key advantages: more natural resources, more capital, superior technology, or better skills. Today three of those "advantages" have become much less important: capital and technology are available everywhere, and natural resources are much less important, since materials can be assembled and produced anywhere.

"The new workplace needs highly skilled people," Houghton says, "people who have learned how to learn, to solve problems, and to think — people who can learn a specific job, and then learn another one." Teamwork, communication skills, and an understanding of quality concepts are also critically needed by companies of all kinds. Today, he points out, cutting-edge corporations are finding that they must look to the arts to find the employees they need. IBM, for example, used to seek out philosophy majors because the company wanted people with analytical skills; and Intuit, the software company, looks for people skilled in teamwork and communication among those with strong arts backgrounds.

"Business changed dramatically in the eighties because it had to; consequently the economic prospects for our children are promising, but only if they are well educated. In 10 years there will be two kinds of people in America, the well educated and the hardly employable."

Honorable Delaine Eastin, California's State Superintendent of Public Instruction

Defining the skills and levels of competency required by business today is the job of the National Skills Standards Board. The Board's goals include helping business create high-performance workplaces. Arts education, Houghton notes, is often the only subject that inspires students to do their personal best, rather than just enough for a passing grade. Consequently, it is becoming an important force in developing the high performance standards so vital to industry today.

The importance of "thinking skills" to the new workplace is evident in the high-performance teams that are today bridging the divide between manual and mental work in corporations throughout America, handling all facets of project coordination, group dynamics, and consensus building. Unfortunately, Houghton notes, the United States has the worst school-to-work transition in the industrial world. It is estimated that six to seven million jobs will be created in this country in the last years of this century, but it is also estimated that less than half of those entering the workforce at that time will be equipped for these newly created high-skill jobs.

Arts education, which demands high performance and develops key cognitive skills — analysis, synthesis, creativity, and decision making — can help equip young people for success in the 21st century. California's state superintendent of public instruction, the Honorable Delaine Eastin, knows the challenges education faces — and the value of arts education. In California, she notes, the arts are assuming an important place in their own right as the basis of numerous jobs in industries ranging from high tech to entertainment. Within the last few years, 200 new multimedia businesses with 60,000 jobs have been added in northern California alone.

Telecommunications and software companies are growing by leaps and bounds. The entertainment industry annually creates new jobs that range from programming to lighting, set construction, animation, and other sophisticated techniques. Digital TV will produce tens of thousands of new jobs. These seemingly diverse industries share some commonalities: all depend on visual imagery for successful operation and all need skilled, creative, and adaptable employees able to work in teams.

"This country's business community has a plan to win in the marketplace," Eastin says, "but it only includes well-educated people. Some people don't like it when I say that, but I happen to believe that's a matter that is largely settled." What then is America's responsibility to its children and to the future? "Schools must adapt quickly to teach the values and skills needed for this world, or our children will not get the education they need. The unadorned truth is that, 10 years from now, there will be two kinds of people in America: well educated and hardly employable. It will be much, much better to be well educated. On our watch, it is our responsibility to reach back into our heritage and, at the same time, reach forward for our posterity, by bringing the arts back into public education at all levels for all children." ■

"The practice and study of the arts is far from peripheral and can be a major building block in giving American business the broad competencies needed as we enter the 21st century. Our success as a nation will depend almost exclusively on the skills of our workforce. A sound grounding in the arts, as part of the educational experience, can only enhance those skills. And people like many of you have the obligation to continue to get this message across to the American business community."

James S. Houghton, Chairman, National Skills Standards Board, and Retired Chairman and CEO, Corning Incorporated

Robert Logan's The Fifth Language—

A Look at Computers as a Language

By David Moursund

Robert K. Logan's recent book, *The Fifth Language—Learning a Living in the Computer Age*, brings an interesting new perspective to computers in education. Logan (1995) argues that computers (along with other related information technologies) constitute a language. He sees this language as the fifth in a series of languages that have developed over time. These languages include speech, writing, mathematics, science, and, now, computers. Logan argues that our educational system needs to be substantially modified to reflect the capabilities of computers as an aid to communication and human thinking.

What Is a Language?

People define the term *language* in many different ways. However, a generally accepted definition is that given by Vygotsky (1962), who described language as a vehicle for communication and thought.

Speech (natural language) is a powerful aid to communication and thought. Logan presents a carefully reasoned chain of arguments that the four other languages—writing, math, science, and computers—each satisfy the generally accepted definitions of language.

A Brief History of Languages

Logan's book also provides an informative summary of the history of the nonspeech languages. He notes that evidence of memory aids far precedes our earliest records of writing. For example, drawings and paintings on cave walls have been dated from more than 30,000 years ago. Tallies (for example, notches on animal horns) were in use more than 15,000 years ago.

Soon after the agricultural age began about 10,000 years ago in Sumer, a country located in the Middle East, agricultural societies began developing individual, uniquely shaped tokens that represented various agricultural products—a jar of oil, a measure of wheat, or a goat. At first, the number of tokens was small—perhaps 24 or so—but as agriculture grew more complex and cities began to develop, the number of tokens grew to as many as 190.

After about 5,000 years, the increasing size of cities and the complexity of agricultural activities made the use of tokens in the information-processing system impractical. Within the next 250 years, writing and mathematics were developed. These were powerful aids to the representation, processing, and communication of information. Because it takes considerable formal instruction and practice to learn writing and mathematics, schools were developed to teach what we now call "the three R's" to government and business clerks. (It is interesting to note that these schools used classrooms and had class sizes much like those in today's secondary schools.)

It took another 2,500 years before the methodologies for collecting, storing, processing, and communicating information overwhelmed the capabilities of the languages of speech, writing, and mathematics. This led to the development of science as an organized discipline—and as a language.

Writing, math, and formal science were tools used by a very limited number of people until technologies for the mass production of paper and books were developed by Gutenberg and others in the mid-15th century. These technological developments made it possible for a significant percentage of the population to gain the knowledge, skills, and power of writing, mathematics, and science.

Finally, it took until the 1930s (about 2,500 years after the development of science as a formal discipline) for the information explosion to overwhelm the languages of speech, writing, mathematics, and science. This information explosion led to the development of computers—the fifth language.

Computers as a Language

Logan bases much of his analysis on the work of Marshall McLuhan, a worldwide leader and visionary in communications. McLuhan coined the term "global village" and the phrase "the medium is the message." McLuhan and others have noted that new languages include their predecessors; they add new powers but lack some of their predecessors' powers. Thus, writing and mathematics did not replace speech, but they certainly empowered their users in ways far beyond the ways speech could.

Similarly, science, including its attendant features—the scientific method; the orderly collection, classification, and analysis of data; and model building—builds on and uses the languages of speech, writing, and mathematics. However, it too provides its users with tools and power far beyond what is provided by these other three languages.

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Computers as a fifth language builds upon the power inherent in the four preceding languages. Computers do not obviate the need for speech, writing, mathematics, and science. However, computers have engendered new tools for the acquisition, storage, processing, and communication of information. Interactive hypermedia and the World Wide Web are two obvious examples. Other examples include tools for composing and/or editing sound and video, software for graphic artists, systems for manipulating mathematical symbols, simulations in the sciences and social sciences, and medical imaging systems.

Educational Implications

It takes a lot of learning time and effort to develop a reasonable level of knowledge and skill in a language. For example, the acquisition of speech begins in very early childhood, and formal instruction in speech (rhetoric) often continues far into a person's educational life. Writing, mathematics, and science are part of the required curriculum in K–12 education and on into college.

Eventually it will become clear that learning computers as a language requires a similar amount of study and practice. In the near future, informal instruction in computers as a language will begin before students start school. Formal instruction will be built into the curriculum at every grade level and continue as part of a college education. All teachers will need to work with their students in the use of this new language.

Educators have a long way to go! Fortunately, many teachers now are comfortable enough in using computers that they can learn alongside their students as they implement new ideas in the classroom. To aid in this effort, ISTE-developed and NCATE-approved standards are in place for teacher education, both for classroom teachers and technology specialists. There is now and will continue to be a steadily rising tide of teachers who have knowledge and skills in the use of computers in education. ■

References

Logan, Robert K. (1995). *The fifth language: Learning a living in the computer age.* Toronto, Canada: Stoddard Publishing Company, Limited.

Vygotsky, Lev S. (1962). *Thought and language.* Cambridge, MA: MIT Press.

# of Information
y in Education

By David Moursund

I have recently finished writing a book about the future of information technology (IT) in education (Moursund, 1997). In this book, I argue that the educational impact that IT has had so far is small compared to what the next 20 years will bring.

Rapidly Increasing Technological Progress

Continued rapid improvements in IT hardware will lead the way. For example, consider the following quote describing a memory chip being developed by a Japanese company.

> NEC is developing a 4-GB memory chip; it will store 47 minutes of full-motion video, or 256 times the capacity of the 16-MB DRAM chip now commonly used. NEC says it will begin selling the chip around 2000 (Pollack, 1997, p. D5).

We all know that steady improvements in transistor technology are leading to faster and faster microprocessors. By the year 2000, the GHz (one billion operations per second) microcomputer will be available. The following quote looks still further into the future.

> Intel chief operating officer Craig Barrett says that the technology now found in \$50,000–\$75,000 workstations of the kind capable of producing images such as found in the film "Jurassic Park" will be available in \$2,000 PCs in just a few years. He also predicts that PCs in the year 2011 will use a billion-transistor chip, compared with about 8 million in the most advanced chip today ("Intel," 1997, p. D2).

Similar rapid strides are occurring in communications technology, as the following quote illustrates.

> Three separate groups of researchers have succeeded for the first time in transmitting information at a rate of one trillion bits per second—a terabit—through an optical cable. Fujitsu, Nippon Telephone and Telegraph, and a team from AT&T Research and Lucent Technologies reached the terabit threshold four years earlier than expected (Association for Computing Machinery, 1995, p.11)

This bandwidth is about 400 times the bandwidth of the optical fibers currently in commercial use.

My analysis of information from many different sources suggests that total worldwide computing power and worldwide bandwidth will each grow by a factor of at least 500 in the next 20 years. It is certainly reasonable to speculate that similar amounts of change may occur in our educational system. The scenario that follows is based on a conservative estimate of a factor of increase of "only" 100 during the next 20 years. This is a compound rate of change of slightly greater than 25% per year.

A Scenario

Take a look at your own school—the amount of computing power in the school and the nature and amount of connectivity. Now, consider each increasing by a factor of 100. If your school is "average" compared to current schools in the United States, this level of increase would provide each student with a microcomputer that is at least 10 times as powerful as today's midpriced machine. It would provide every student with connectivity to worldwide and local area networks at a bandwidth that supports high-quality interactive video.

Consider a scenario 20 years in the future: Every student has a personal portable microcomputer for use at home and at school. Wireless connectivity to local and worldwide networks is provided in every classroom. A wide range of software tools and educational software is available to every student. Computer-assisted learning and distance education are routine parts of the teaching and learning environment, both at school and at home. These methods of instructional delivery provide access to instruction in the full range of coursework that is appropriate to K–12 students. The combined power of current hardware and software supports high-quality voice-input systems. Tool and educational software are both "intelligent"—that is, they reflect the steady progress that has been occurring in artificial intelligence.

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The market forces in IT are driving the technological changes that make this scenario plausible. These forces are driving the development of more powerful computers, increased bandwidth of networks, and increased connectivity. Such progress will occur independently of whether the facilities are made available to students in any particular school or school district.

Similarly, computer-assisted learning and distance education are also driven by market forces. These aids to teaching and learning will continue to improve and will become more available, independently of choices made by individual schools or school districts. The home market will be one of these driving forces.

Personal Implications

Such scenarios that speculate about the future are useful in considering the present. Suppose that the scenario is an accurate prediction of what many schools will look like 20 years from now. What do you, personally, intend to do about it? What are the main thrusts of your professional interests in IT? For example, are you interested in the acquisition and maintenance of hardware, software, and connectivity, as well as technical support for end users? Or are you more interested in professional development—that is, helping all teachers learn to use IT effectively? Do you want to be involved in curriculum development and assessment—integrating routine use of IT throughout the curriculum? Or, do you hope to be a high-level leader—one who facilitates large numbers of people working to accomplish the previously mentioned tasks? (There are now a small but growing number of assistant superintendents for IT.)

Whatever your answer, you face the challenge of continuing rapid change. You need to develop a network of people and sources of information that can help you meet these challenges. The International Society for Technology in Education (ISTE) can be one part of the help that you seek. It is a source of high-quality information as well as a vehicle for getting connected with people like yourself. And, ISTE's publications can help you to stay abreast of your professional field. ■

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References

Association for Computing Machinery. (1996, May). *Communications of the ACM.* New York: Author.

Intel view of the future. (1997, Apr. 23). *New York Times*, p. D2.

Moursund, D. (1997). *The future of information technology in education.* Eugene, OR: International Society for Technology in Education.

Pollack, A. (1997, Feb. 7). Japan chip maker unveils next-genera-[illegible]ı prototype. *New York Times*, p. D5.

Letters

Math Article Inspires Further Exploration

Thanks for the article on repeating decimals in *L&L* ["Number Patterns in Repeating Decimals" by Leon Roland, March 1997 issue], and for that matter, for the increased math coverage. In 1974 I explored these patterns with students at Los Altos (CA) High School, using a time-sharing system connected to a remote HP 2000, which was donated for student use. We missed your observation about the powers of primes—that's nice. We found out that the reciprocals of primes repeat in a block whose length is a factor of p-1, but I never was able to find a reference to this result or a proof. I wonder if you have found any research on the subject in the math literature.

In my files I found the teletype printouts for the primes under 10,000, and for some primes above 50,000. The latter run was interrupted by the sysop with the remark, "That is enough number crunching please—notice the time used?" We had done about 500 primes in an hour and 20 minutes.

I've never returned to this problem with computer or graphing calculator, but maybe now I will!

Thanks!

William J. "Sandy" Wagner
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We contacted Leon Roland, who said that he had seen no research on that subject that he was aware of. We would like to add that we all enjoyed reading about the differences between then and now regarding the computing power that was available to teachers and students. Thanks, Sandy!—Ed.

We're All Ears!

The collective response from our Readers Survey in May was not only outstanding, it was unprecedented. We received *five times* more replies than last year from *Learning and Leading With Technology* subscribers like you. Results from the enthusiastic feedback will prove to be quite valuable when planning future issues—especially by providing us with helpful suggestions and better insight about the needs of our readership.

We would like to send a sincere "thanks" to everyone who took the time to respond. We look forward to hearing from you again at the end of this volume.

Below are the 1997 survey winners, picked in a random drawing. The following readers will be receiving one full year of ISTE membership, complete with a subscription to *L&L*:

1. Aldo Aguirre (Las Vegas, NV)
2. Paula Conley (Coeur DÁlene, ID)
3. Henry Dewey (Williamsville, NY)
4. Mary Jackson (St. Louis, MO)
5. Monika Preuss (Elmhurst, IL)

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School Is Not Enough: Learning for the 21st Century

By John Abbott

SUCCESSFUL PREPARATION OF OUR YOUTH FOR THE 21ST CENTURY WILL REQUIRE NEW MODELS AND UNDERSTANDING OF HOW WE LEARN AND DEVELOP INDEPENDENCE—AND THE INVOLVEMENT OF THE ENTIRE COMMUNITY.

The strategic center of the 21st century has to be individual and group learning. Successful individuals will be those who can direct and manage their own learning as they navigate their way through several careers over the course of a lifetime. Successful companies will be those that can facilitate learning teams, and provide the environment for innovation and creativity. And successful communities will be those that maintain and nurture civil society through developing systems and relationships that help foster lifelong approaches to "learning how to learn," which enable self-sufficiency and the participation of all members in the life of the community.

Humans have been learning to use their brain ever better with each generation over millions of years. There is one exception, and that is what has happened over the last five or six generations. This may at first sight seem a paradox. Until the early 1800s people learned in real life, on-the-job situations. They were essentially inclusive learners—they had to use all their faculties. Then the pressures of an industrial society required people to develop no more than a range of functional skills (such as reading, writing, calculation, etc.) that enabled them to fit into an industrial society—for most people this meant the dull routines of manufacturing industry. The more inclusive skills that enabled people to make sense of things for themselves in earlier ages were largely ignored.

Humans have been learning to use their brain ever better with each generation over millions of years [with] one exception.

Formal schooling as we know it is largely the creation of the last 100 or so years. Its achievements have been immense, and it has been widely replicated around the world. Yet, for all its achievements, it is eventually limited by the technology of the classroom, formal instruction, uniform stages of progression, prescribed knowledge, a curriculum of self-contained bits and the fact that no child in Western Society spends more than 20 percent of his or her waking hours in a classroom.

Holding on to the belief that learning and schooling are largely synonymous is severely inhibiting our ability to prepare for the opportunities and challenges of a true global economy.

Fortunately, a new model of learning is emerging based on current understandings about the brain, about human intelligence, and about human memory. This is coming out of cognitive science, neurology, evolutionary biology/psychology, cultural anthropology (even from archeology), as well as pedagogy, conventional psychology and systems theory. In addition to these new understandings, radical developments within information and communication technologies are beginning to change how young people acquire the information they need to build knowledge, and develop the abilities to meet the challenges and opportunities of the Knowledge Age.

The belief that learning and schooling are largely synonymous is severely inhibiting our ability to prepare for...a true global economy.

Medical and cognitive sciences, new technologies and a vast array of pedagogic research are helping us to appreciate far more about just how the brain works. The brain is, literally, the most complex living organism in the Universe (some call it "The Cathedral of Complexity").[1] Although it weighs only about three pounds, it is made up of approximately one million, million cells. By way of illustration, that is roughly all the stars in all the galaxies in all the universe. The total length of the "wiring" between the neurons is roughly about one hundred-thousand kilometers. Professor Susan Greenfield, when lecturing a group of fourteen year olds, at the Royal Institution in London, compared their memory capability with that of a thousand CD ROMs, each one containing an entire Encarta Encyclopedia.

While it is essential for scientists to understand the molecular details of brain chemistry, for all practical purposes it is the science of complexity that enables us to make greater sense of the numerous layers of organization within the brain that act together, apparently miraculously, to handle not only memory, but also vision, learning, emotion and consciousness.

The human brain, in all its structures and processes, is a direct response to the complexity of the interaction of all those factors in the environment that man has had "to know what to do about" since the beginning of time. Until about half a million years ago the brain changed through evolution but very slowly.

Our brains then started to grow more rapidly as we learned to use language. It has only been within the last 30–60 thousand years, that we have developed the capacity to be "broadly intelligent."

What does that mean? Archaeology, as well as Cultural Anthropology, is starting to show that while humans have developed a number of discreet skills over a million or so years (social intelligence, technological intelligence, natural history intelligence, language intelligence, etc.) it is only recently that we have been able to combine these intelligences to create that broad intelligence which now gives us our amazing versatility. The cave paintings discovered at Chauvet, in France, in 1994, date exactly from this period of 30 thousand years ago. They are highly sophisticated and represent the coming together of social, technological, and natural history intelligence. They seem, as it were, to have leapt out of nothing. We know of no "primitive art" that preceded it—probably there wasn't any. With the emergence of broad intelligence, modern man came to be.[2] Archaeology is starting to endorse Howard Gardner's call to educationalists to work with all of children's many forms of intelligence. That is what gives us our creativity.

It is only recently that we have been able to combine these intelligences to create that broad intelligence which now gives us our amazing versatility.

The brain is adept at handling a variety of situations simultaneously; historical facts are fitted into mathematical patterning when the brain is comfortably challenged, within a non-threatening situation. Psychologists and cognitive scientists call this a state of "flow;" a state reached when a person becomes so engaged in what he or she is doing that all tasks seem within one's capability.[3] It is that which makes it possible for each of us to react, moment by moment, to our immediate environment while also thinking about a number of abstract matters. The brain handles this complexity through several layers of self-organization whereby vast interconnecting networks are established. It is as if the brain is constantly "re-tooling itself" to work effectively in new and emerging situations. Once established, traces of these networks appear to survive almost indefinitely, and are frequently used as solutions to new problems. It is these earlier traces that give the brain its ability to build new ideas.

Neurologists are now beginning to see some forms of memory in operation (i.e., they can literally watch specific patterns of activity within the brain light up on a computer screen as a result of Functional MRI and PET Scans). To the researchers' surprise, memory does not exist in just one, but many, locations in the brain. Some people compare memory to a hologram where the whole exists in all the parts. Memory traces seem to follow those neural-networks that the individuals—at the time of original thought—found most to their advantage. The neural-network might have been activated for only a short time, and designed for a specific purpose that is no longer applicable, and may well cross many "domains," but even when that route is no longer needed, a trace of its past activity is still present. Nothing, it seems, is ever irretrievably "lost," though just how it is that we can access memory more effectively at some stages than at others still eludes us. If part of the network is later activated, it may well "question" why it is not being asked to complete the original set of connections.[4]

Archaeology is starting to endorse Howard Gardner's call to educationalists to work with all of children's many forms of intelligence.

All this is done spontaneously in response to challenge. The brain does not have to be taught to learn. Learning is what it does—automatically. To thrive, the brain needs plenty of stimulation, and it needs suitable feedback systems.[5] Effective learning is dependent upon emotional energy. We are driven (the ancestral urges of long ago) as much by emotion as by logic. Children who learn because they simply want to work something out because it matters to them, are far more resilient and determined when they face problems than children who seek external rewards. The same goes for adults. Intrinsic motivation is far more significant than extrinsic.[6] When in trouble the first group searches for novel solutions, while the latter looks for external causes to blame for their failure.[7] The brain is essentially a survival system, it takes seriously those things that matter to it. Emotional well-being may well be more essential—to the brain—for survival, than intellectual.[8]

Too much stimulation, however, at any stage in life, turns a challenge into a threat. The brain deals with this easily. It just "turns off." This is seen, dramatically, with MRI. Give a person a mental task that interests them, and many parts of their brain are seen to "light up." Persistently insult that person and he or she goes into a form of mental defense. The lights literally go out. "Down shifting"—a phenomenon long recognized by psychologists—is a strictly physiological defense mechanism. To work effectively at a challenging task, research is now suggesting, requires among other things significant amounts of reflective activity. "I need to go away and think that over" is a critical part of brain functioning.[9]

Since no two brains are exactly alike, no enriched environment will completely satisfy any two individuals for an extended period of time. No matter what form the enrichment takes it is the challenge that matters: passive observation is not enough, it is interactivity that is so essential. "Tell me and I forget. Show me and I remember. Let me do and I understand," says the ancient Chinese proverb.

"Tell me and I forget. Show me and I remember. Let me do and I understand," says the ancient Chinese proverb.

With these new understandings of the brain, we are now in a far better position to fuse formal learning structures onto natural learning predispositions that extend them "beyond what comes naturally." Simply put, we now know how to make it possible

for people to become better learners. The implications of this for society and for the economy are massive.

The ability to think about your own thinking (metacognition) i[illegible]ential in a world of continuous change. In this way skills [illegible] developed which are genuinely transferrable, and which are not tied to a single body of knowledge. These are linked to a form of intelligence known as reflective intelligence. Some people call this "wits."

Such expertise as implied by wits—the ability to step back as a specialist and honestly re-evaluate what you are doing in terms of a general perspective—is by its very nature, a skill more naturally developed in the rich collaborative problem-solving and uncertain world of the apprentice, than ever it can be in the formal classroom with its inevitable emphasis on tasks, schedules, and measurable activities. Expertise is difficult to achieve without being a specialist, but it is much more that just specialism. It requires the knowledge of much content, and the ability to be able to think about this both in the specific and the abstract.[10] It is essentially that deep reflective capability that helps us break out of set ways of doing things, unseating old assumptions, and setting out new possibilities. It is the essential ability necessary to face a world of economic, social and political transformation.

Just as we are undoubtedly on the brink of new understandings about learning, so too are we beginning to see how radical developments in technology can enhance how young people acquire information and assimilate knowledge. The Internet is encouraging the development of virtual learning communities that sh[illegible] ideas and concepts, develop group understandings, and e[illegible]icite action.[11] Learning is essentially a social, collaborative problem-solving activity, and the Internet enables these virtual learning communities to thrive.

Learning is essentially a social, collaborative, problem-solving activity, and the Internet enables these virtual learning communities to thrive.

Information and communication technology can enhance human learning because we form our own understandings through a multiplicity of interactions, and draw continuously upon the thinking of countless earlier generations. Such learning arrangements as offered by information and communication technology are highly compatible with the natural functioning of the brain, with what we know about human aspirations, and in particular what is now known about the adolescent's need to feel involved and of value.

Conclusion

A model of learning that could deliver real expertise—abilities acquired through effort that carry us beyond what nature has specifically prepared us to do—could be ours now for the asking[illegible] would work on the basis of the biological concept of w[illegible]g...giving young children all the possible help they might need when they are very young, and then reducing this pro[illegible]y as the young master more and more skills. Thus, as adolescence ends, the young person has already taken full responsibility for managing and directing his or her own learning. The age of 18 should not be the age at which people start to become independent learners, but the age when they demonstrate that they have already perfected that art, and know how to exercise this responsibly.

Formal schooling, therefore, has to start a dynamic process through which pupils are progressively weaned from their dependence on teachers and institutions. They are given the confidence

The 21st Century Learning Initiative

The 21st Century Learning Initiative is a transnational program to synthesize the best of research and development into the nature of human learning. Its purpose is to inform and stimulate public debate on how this can be used to improve education, work and the development of communities worldwide.

Mounting evidence worldwide suggests that traditional education systems are increasingly becoming dysfunctional in the face of escalating technological, social, and economic change. Profound questions are being asked as to why so many young people seem so ill-prepared for work or for participation in civil society.

Daunting as these issues are, a growing number of world-class researchers, educational innovators, thinkers, and policymakers from several countries, together with concerned funders, believe solutions await development and have started to meet under the auspices of this Initiative. They are convinced that change can and will take place if they take collective action to exploit new insights emerging from an increasing array of research into just how it is that people learn-how-to-learn (and thereby develop real understanding and transferrable skills), and then link these findings with the experience gained from successful and innovative practices worldwide.

The Initiative, registered in June 1996 as a nonprofit U.S. organization, was initially set up by the Education 2000 Trust in the United Kingdom with key support from The Johnson Foundation and several anonymous funders in the United States.

The Initiative, having completed its first stage by finaliz[illegible] its membership and completing the initial Synthesis [illegible] on human learning, is now preparing [illegible] second stage that will consist of three components [illegible] the Synthesis document on human learning [illegible] promotion and dissemination of the research [illegible] and [illegible] innovations outlined in the Synthesis [illegible] the [illegible] grassroots level. Linking Research [illegible] forming of partnerships with [illegible] at all levels who are already trying to [illegible] communities and education systems [illegible] within the Synthesis [illegible] This third component [illegible] review [illegible] Synthesis to be updated [illegible] findings about the natur[illegible] worldwide.

[illegible] information on the Initiative [illegible] telephone 202-862-1698 [illegible]

John Abbott directs The Education 2000 Trust, a British not-for-profit that links leaders from education, industry, and the social sector on behalf of "whole systems change" in education. He came to fame in England as the young head of the 16th Century Alleyne's School, which he developed into an all-ability school for 900 boys and at which he set up England's first computerized classroom. Since early 1996, Abbott has been in Washington, DC, leading The 21st Century Learning Initiative (see page 31).

to manage their own learning, collaborate with colleagues as appropriate, and use a range of resources and learning situations.

To achieve this, the formal school system and its current use of resources has to be completely re-appraised, and effectively turned upside down and inside out. Early years learning matters enormously; so does a generous provision of learning resources. If the youngest children are progressively shown that a lesson about learning something can also be made into a lesson about how to "learn-how-to-learn" and remember something, then the child, as he or she becomes older, starts to become his or her own teacher. In industrial terms, the child ceases to be totally dependent on the teacher as an external force, and progressively becomes part of the "learning productivity process." The older the child becomes, the more the child as a learner becomes a resource that the community has to come to value.[2]

By reversing staffing ratios, creating smaller classes, and providing the best teachers in the early years of elementary education (developing as a matter of course a very particular style of education), children would be provided with an ever-richer array of learning resources as they get older. The Knowledge Age by its very nature represents an increasing dispersion of knowledge at all levels of society and within all organizations. Therefore, if adolescents are to develop the skills and attitudes necessary for a knowledge economy, it is essential to view learning as a total community responsibility. It is certainly not just teachers who must teach nor students who must continually learn, and it is not just the classroom that is the major access point to a range of information and expertise on which knowledge is built.

Good schools alone will never be good enough. Successful societies in the 21st century will have learning communities that are in-line with the needs of a continuously changing economic and social environment. ◄

This article was based on the work of The 21st Century Learning Initiative. Special thanks are extended to my assistant Terence Ryan for his help in writing this article.

ENDNOTES

1. Peter Coveney and Roger Highfield, *Frontiers of Complexity: The Search for Order in a Chaotic World* (Fawcett Columbine), 199[illegible].
[illegible]
[illegible] Renata and Geoffrey C[illegible], *Making Connections: Teaching and the Human Brain* (ASCD), 1991.
6. Alfie Kohn, *Punished by Rewards* (Houghton Mifflin), 1993.
[illegible]
[illegible] Abbott, *Learning Makes Sense: Recreating Education for a Changing Future* (Education 2000), 1994.

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Developing Leadership for Education in a Cyberspace Age.*

A Report of the Design Forum Convened at the Harbour Centre Campus of Simon Fraser University, March, 1996.

Dr. Milton McClaren, Director, Field Relations &
Teacher In-Service Education,
Faculty of Education.
Simon Fraser University.

*A joint project of the BC School Superintendents' Association and Simon Fraser University with financial support by the partner organisations and by the Ministry of Education of British Columbia.

Leadership and education technologies.

The question of developing educational leadership in the context of a world in which information and computer technologies, broadly the synergistic merger of computers, communications, publishing, video, film, and radio, is transforming our world and with that transformation many forms of work and recreation, resolves into a question about leadership and a question about infotechnologies in the context of schools. In March, 1996 the BC School Superintendents' Association, in partnership with Simon Fraser University's Faculty of Education convened a Design Forum on this broad topic and the two component themes: infotechnologies in schools and educational leadership. The sponsors invited some of the outstanding practitioners in the field from within the B.C. system to discuss this topic, and to think together about it, in an extended conversation which ranged over a 1.5 day period. The group was structured to be as representative as possible, but with the goal of keeping it sufficiently small to enable all to be active participants. Simon Fraser University is the coordinator of the National Network of Centres of Excellence in Information Technologies and has activated a large, cross university initiative known as the Virtual University Project, so a number of representatives from the university participated in the forum. The membership of the BCSSA are involved in planning and implementing infotechnologies in public schools, especially within the context of the Ministry of Education's District Technology Planning Process. Thus, the BCSSA has a direct interest in the question of leadership in this field. The commentary which follows is not intended to be a direct review of the discussion which occurred during the forum—that would simply be impossible and relatively useless given the extremely wide ranging, free-flowing, creative as well as critical nature of the conversation. Instead, what follows might be termed an overview of the major issues and an attempt to summarise the Forum's agenda for future work and development.

I. Infotechnologies and Education.

The desktop computer has become so much a part of the lives of many people in education that it is easy to forget that the technology is a very recent innovation, especially as an appliance in households and classrooms. Even more recent is the advent of the personal computer linked to other remote computers via the telephone system and a modem. And, virtually a newborn, is the arrival of cyberspace, an electronic environment inhabited, at least potentially, by every computer on the planet, and thus by every computer user. But, exactly how has this amazing dispersion of computers and infotechnology affected schooling?

As Crawford puts it,

> *Ever since computers started showing up in our classrooms fifteen or so years ago, educators have sensed incredible potential for educational application and reform in them. However, in reality, computers have not been a source of any really significant reform but rather, merely an addition to the existing curriculum. The sense of potential is still there but not its fulfilment. In an era so heavily based on technology we have been merely "integrating technology into our curriculum rather than integrating our*

curriculum into technology" (Thomas Sobol) For the most part all we have really done is used the new technology to "speed up" the old way of doing things rather than to reform it. The computers are not enough. We need something else. A major piece of the puzzle has been missing all these years. Jack Crawford, 1995. Reprinted from On the Horizon, an Internet based forum for the discussion of issues of change in Post Secondary Education.

Some years ago Steve Wosniac, co-inventor along with Steve Jobs, of the Apple® personal computer, suggested that new technologies pass through three broad phases of adoption or cultural dispersion. The first is termed recreation or novelty, in which the new technology is seen as an item of curiosity and attracts the interest of a small segment of the population. The pages of magazines such as Popular Mechanics or Mechanics Illustrated are filled with inventions and processes which never got beyond the stage of being a curiosity or a prototype. But even inventions such as the aeroplane passed through this stage: at first the plane was seen simply as a curiosity, a recreational diversion for odd sorts of people; few seriously believed that these strange looking craft would change the way the world worked. The personal computer, and even the mainframe passed through this stage as well. Long before the first commercial Apple computer or PC, hobbyists could buy kits with which they could assemble a digital computer. But the final product was not seen as a serious tool: what was important was the challenge of actually building one, and then programming it to perform some simple mathematical operations. Even the senior administrators of IBM at first saw no reason why an average person would ever need, let alone want, a personal computer at the desktop. The early days of personal computing were marked by a plethora of trivial games which often seemed to be the only reason anyone would want to use a computer.

The second stage of technology dispersion might be termed "improvement". In this stage the technology lets you do the same things that you have always done, faster, or more efficiently, or with less effort. The electric toothbrush is an improvement, possibly, on the hand operated model, but the basic process of personal dental hygiene is unchanged. The electric typewriter was faster than the mechanical model. As the personal computer became more widely available at a lower cost users began to apply them to tasks like word processing and accounting. Word processing software and spreadsheets definitely improve the way text is formatted and the spreadsheet makes it possible for average persons and small businesses to do tasks which were once only in the domain of large corporations. But, the basic concepts of accounting and text-based communication are not challenged by these tools and software. However, as more and more users began to become familiar with the potential of infotechnology through daily contact with a personal computer, they started to think of new applications and of ways to replace or restructure existing ones. This lead to the third stage in the cycle of technology dispersion—transformation.

In this stage the technology begins to make it possible to change the way the world works in the domains affected by it. Thus, the coming of the laser printer linked to the development of affordable desktop publishing software revolutionised the capacity of people not only to read printed works, but to produce them. Entire categories of work disappeared or

were radically altered. Even highly skilled technical trades such as Linotype operation became redundant. It became possible to develop just in time manufacturing, tele-registration, automatic banking machines, and a host of other applications which changed the lives and work of millions.

The personal computer and its associated peripherals such as laser printers and modems have passed through these three stages very quickly. In fact, in some ways all three stages coexist in the present. The Internet is simultaneously a diversion or curiosity, a means of improvement of existing functions, and a vehicle for transformation. In most educational institutions the struggle to move from Stage 1 to Stage 3 is very evident. In order to understand the struggle one must ask a simple question:

"How are schools with computers and infotechnology different in any significant ways from schools before their introduction?" If this question was asked of people in many areas of work, publishing for example, or engineering, or architecture, the answer would be fairly easy and it would often show that the advent of infotechnologies radically altered how things "worked" in those fields. But in terms of schools, could any fundamental or radical change be identified as a consequence of these new technologies.

When this question is asked of educational administrators they often point to the fact that computer technology has greatly changed the payroll department, or has made it possible to have a much better control of library-inventories or equipment and supplies. In some cases the combination of computers and networks has even taken over the regulation of school heating and air-conditioning plants so that they are monitored centrally in order to produce the greatest savings in energy costs. But at the core school functions, learning and teaching, what has changed?

This question is not as simple as it may appear. When broadcast TV was introduced many pundits called for fundamental changes in the way schools operated. They foresaw the flying professor who would lecture to 1000's of students from a TV station in an aeroplane—this was, after all, before the space satellite. Others predicted similar radical changes to the delivery of instruction with the arrival of the radio. Teachers often point out that neither of these technologies eliminated the classroom and the teacher doing more or less traditional tasks, so why should computers be any different? These teachers however miss the point—TV didn't transform schools by being adopted and used in schooling: instead TV changed schools because the kids walking through the doors in the morning are different than those who came to school in the era before TV. Of course, many schools don't appear to have recognised the changes to the clientele in the manner of their daily routines and operations.

It is quite possible, therefore, that infotechnologies may have their greatest change on schools from outside, by changing the way parents and kids appreciate and understand the world and by changing their access to instruction and resources and providing more control over the scheduling of learning opportunities.

What then are the characteristics of schooling as a process or social organisation to

nurture human learning without infotechnologies?

§ The teacher is the major source of both support for learning and information. The teacher processes information and decides what will be taught, when, for how long, and in what manner. Even so-called learner centred classrooms usually reflect a decision made by a teacher, not by students.

§ The schedule controls the availability of the scarce resource, teachers/teaching to the student. The student must show up for instruction or tutelage according to the scheduled availability of the critical, scarce human resource—the teacher.

§ The other scarce resource is time. Because the teachers are in short supply, the students must be grouped for instruction. This necessitates the creation of classes which meet at scheduled times, for fixed durations. If a learner needs more time, or less, or a different arrangement of time, this is often not possible or is not under the learner's control.

§ The school staff constitutes the major resource for the students, and particular teachers are of particular importance to the students in their classes. While there may be talented teachers in other classes,schools or cities these are not typically available to students in general, and certainly not in an interactive, or as needed, just-in-time fashion. The second major resource for student learning is the text book. This resource is not selected by the students, and often is not selected by the teacher either. While there may be many other excellent textual resources, they may not be available to the students or teachers, or certainly will not be available on-demand, as needed, when needed.

§ While the sophistication of human interactions makes possible the use of teaching strategies which can adapt to the learning situations and styles of a wide array of learners, the scarcity of time, and resources, especially human resources, reduces much instruction to stand-and-deliver, content coverage models. Teachers don't have the time and resources and aren't expected to tailor instruction to meet individual learning needs. The class, not the individual learner is the instructional modulus. The demands of content coverage and the constraints of the schedule preclude the use of more sophisticated learning/teaching methodologies. In a world of expanding information the torrent of content overwhelms meaningful learning and teaching.

§ The dominant sub-text in schooling is that students are not smart enough, or trustworthy enough, or motivated enough, to take responsibility for their own learning. A minor, but important theme below this sub-text is that teachers also can't really make wise choices about what should be taught, how, to whom, and when. Thus, schools are systems to control what is taught and learned, and to check to make sure this is done. The fundamental structure is a hierarchy, although control is enforced via an assembly line methodology.

If these are some of the characteristics of schools without infotechnologies, what might be possible with these systems if their full powers where made available to support the educational development and educational goals of people?

• Learners could use infotechnology to access a virtual world learning community. This would mean that any learner, anywhere, could have access to significant resources needed to support his/her learning projects.

• The fact that "servers never sleep" means that learners could access the resources needed to support learning virtually on demand. While groups might want to do this together, because a group wanted or needed to work together on something, an individual could chose from a 24 hour day, seven day week, 365 day schedule of access. (An interesting illustration of the on-demand/as needed principle is the dispersion and impact of the ATM. Only a few years ago, especially before the advent of credit cards, if one needed money it was necessary to go to a bank and deal in person with a teller, often at the specific branch at which your account was registered. Today, people can access banking services and obtain cash from virtually anywhere in the world as long as they have a bankcard. Few people would willingly return to a world where cash and banking services where available only from 10-3, 4 or 5 days a week—but that is how it was not so very long ago. In passing it might be noted that banks themselves are clearly modernist/industrial organisations in the way they typically work and in most of their assumptions about economics; however, it may well be that globe spanning infotechnologies such as those which enabled the ATM are the cuckoo's egg in the banking nest and will lead to the fundamental transformation of these institutions. Stay tuned for the arrival of cybercash!)

• If the focus is placed on learning as a continual life long process, then there is no need to create arbitrary schedules for the completion of phases of it. What is necessary is to make progress, to engage in the enterprise, to do the work. Because of the tireless availability of on-line supports there would be no need to fix time and make learning the variable; instead we could make time the variable and learning the focus of the enterprise. There would also be no need to break learning projects into arbitrary time slots; if a learner is ready and willing to work on a math learning project for 6 days in a row in order to develop power and depth of understanding, why not? His/her virtual classmates don't care. The teacher doesn't have to rearrange his/her schedule to accommodate this need, but it can be accommodated.

• The virtual learning community can take many forms: material resources in text, pictures, speech, music, sounds, stills and movies. The community can be mentors, tutors, coaches, peers, masters; the learner can work alone or in a group; the group can be real, or virtual, or both. If one teacher doesn't suit the style and needs of the learner, he/she can find another. If a teacher can't help a particular learner, for whatever reason, the teacher can connect the learner to another teacher who may be better able to work with that person.

• On-line learning systems can monitor student/teacher activity and make suggestions re the management of the learning process itself. Thus, a learner information system might suggest the timing and nature of assessments, it might provide templates for the planning of projects, for time management, or arrange particular resources which might be overlooked by the learner or the teacher. It could suggest remedial measures and arrange for them. It could refer the learner to face-to-face instruction or support. It could flag special

difficulties for teachers/coaches/or tutors.

• The curriculum can become a living entity. Within a broad framework of goals and purposes the curriculum can be developed to suit the particular learner or teacher. If we still subscribe to the notion that there must be a common or core curriculum required to be studied by, and accomplished by all learners, then the emphasis should be placed on the diversity of the learners and instructional approaches rather than on the content. Information technologies should make it possible to customise content, approach, timing, assessment.

• The class becomes a matter of choice, an aide to learning, not a necessity imposed by scarcities.

These contrasting lists of possibilities call into focus some of the differences between the educational arrangements we have without information technologies and those we might have with them. The difficulty we appear to face is that schools and schooling are institutions of an industrial/modernist world while those we might have are associated with a post industrial, post modernist world. As was once said of Galileo, the one world is dead, and the other is struggling to be born.....except that in this case the one is losing power and moral force while the other is struggling to be born.

The problem with trying to fit post industrial technologies or approaches into an industrial institution is that it simply doesn't work. The result is an institution that is neither fish nor foul and doesn't have the capacity to be amphibious. When attempts to fit post modernist systems into modernist structures fail, the automatic response is to return to the old ways—after all, the new hasn't actually been born yet. But, by returning to the old we doom the new to stillbirth because we recommit the essential resources required for change to the old order of things. Thus it is that whenever profound educational change, which is usually in the direction of post industrialism, falters, the immediate response is to return to what is known. But it is the worst possible response because, in spite of the fact that people will say, "we tried that and it failed" this is not true. We almost tried it, and when it looked as if it might fail we made sure it would fail by withdrawing all the supports which might have made it successful. It is as if, after an early unsuccessful Wright Brothers flight we banned further attempts, drove the inventive brothers into bankruptcy, and then reassigned them to work as blacksmiths in a shipyard. The problem of attempting innovation within established cultural institutions is well known. It is so difficult that many innovations which might have seemed quite able to appear in the midst of existing structures which might have nurtured their development instead make their debut outside these structures. Of course, this is especially true when the innovation threatens not just how things are done, but those who hold power or status through that way of working. Which brings us now to the question of Leadership.

II. Leadership in a World of Cyberlearning.

So, the question becomes, can the post-industrial virtual learning community come into existence inside the belly of the industrial school? The answer is likely not one of

technology, or insight, or intelligence, but one of vested interest, power, and control. If we ask who is in power and control of the industrial school we will not get the answer that it is the learners. Schools are often characterised as having teaching as their dominant function. If this is so, then teachers are those who hold power. But, if the actual answer is that it is the curriculum (or learning outcomes, or standards) and those who activate them which has power, then neither the learners nor the teachers have control. If post industrial, post modernist systems such as infotechnology challenge power arrangements then they will be seen as a threat to the established order of things and while the system may pay lip service to the use of such systems, they will be tolerated only within the current set of arrangements and assumptions. This dooms technologies with potential transformative power to a role as improvements at best, and to that of marginal triviality or curiosity at worst.

What kind of leadership is required to address these problems? Can such leadership be expected within the structure of institutions which are primarily modernist/industrial in nature. If we need leadership not for maintenance of the current order but rather for its transformation or fundamental restructuring, then what sort of support and development does such leadership require? This question must be at the heart of any real discussion of leadership for education in an era of global information technology.

In his contribution to the State University of New York's series on constructive post-modernism, David W. Orr (1992) makes the observation that the very concept and metaphors of leadership are deeply rooted in the industrial paradigm. The leadership most often cited as exemplary is that of the "man on the white horse" (or in the white house). It will be, of course, male (even when the leadership position is actually occupied by a woman). It will be fearless, linear, forceful, and energetic. It will overcome opposition through the sheer weight of charisma. It will inspire followers to trust in it, and to assign their own need to think and make decisions to the leader.

Post industrial or post modern leadership is quite different. To use Robert Greenleaf's term, it might better be characterised as servant-leadership, He proposes the following test of leadership: "Do those served grow as persons? Do they, while being served, become healthier, wiser, freer, more autonomous, more likely themselves to become servants? And what is the effect on the least privileged in society; will they benefit, or at least not be further deprived?"

"The servant leader emerges through a long, arduous discipline of learning to listen,first. " Transformative leaders, Orr proposes, will be persons possessed of vision, spiritual depth, intellectual breadth, courage, and the drive to serve. "Such leadership articulates what people feel in their bones, then translates this into a coherent agenda of reform and change within the context of familiar values of justice, fairness, peace and democratic participation."

This is a very different vision of leadership. But it is one which is recurrent in a great deal of literature about learning organisations and post-modernist structures. However, it cannot emerge, or will not be tolerated if it does appear, in industrial organisations whose members expect industrial leadership. Many people like to be told what to do, and to

assign the need to think for themselves to someone else. In this century alone we have many examples of this at the nation-state level of organisation: Hitler, Stalin, Peron, and Tito. And, even though the industrial leadership paradigm is fundamentally counter to the ideals of democracy, more than a few politicians in modern (not post-modern) democracies succumb to the temptation to assume the garb of chauvinist/father/leader, often because their pollsters tell them that this is "what the voters want."

Thus, if post-modern technologies such as computers and infotechnology cannot thrive in industrial/modernist organisations and paradigms, neither can post modernist notions of Leadership and Followership. What is required is to nurture the development of an organisational culture which will make full use of infotechnologies in the service of learning for educational development. How might this be done? There are a number of possible approaches.

∞ 1. Create a school-of-the-future: this school would be a test platform in which to work out the concepts of post-industrial schooling and could become the prototype for others. The model appeals to many people, including those opposed to change because it effectively isolates the innovators and the innovation into a "research park". While some research parks, like the Palo Alto Research Centre (PARC) operated by the Xerox corporation, it is instructive to note that the designers of the Graphic User Interface which became the O/S for the Macintosh® computer and drove the development of the Windows® extrusion to D/OS couldn't find a hearing inside the PARC and had to leave to get their work done.

∞ 2. Create a Catalyst, a tool for pattern dynamite: the example here might be Aldus PageMaker® (now Adobe PageMaker®) although other software has also made a revolutionary impact on other fields of work. It can easily be argued that Paul Brainerd, through the invention of PageMaker, combined with postscript driven laserprinters as developed by Apple™ Computers revolutionised publishing. This software not only changed the processes of publishing textual material, they brought publishing to the personal level. As an early add said, freedom of the press resides not in the right to read books, but to publish them. Thus, desktop publishing software opened up the entire production system for books and other publications and changed the way people thought about the printed word. Now, through desktop video and multimedia, the revolution is continuing and it is manifest in software such as Netscape®, which has made the World Wide Web of the Internet the phenomenon that it is.

What do these examples have to do with infotechnologies in education? A case can be made that so far, while software like Pagemaker, word processing, spread sheets, graphics programs, and databases have all been adopted by schools, none of them were really designed specifically to support the work at the core of the school system—human learning. If a software (and perhaps hardware combination) could be developed specifically to bring the best of current knowledge about learning and instruction to the desktop of every person with a learning project, it could have the same impact as things like PageMaker in the field of publishing. The development of such a tool, especially working through the Internet in a way comparable to Netscape, would have the potential to revolutionise the way society supports and organises (and we might add, controls) learning.

This is not a simple task, but it is doable. Netscape is based broadly on concepts put forward by Vannevar Bush (in a 1946 Atlantic article entitled As We Think....) and Ted Nelson (the Xanadu Project) in the 60's and 70's. However, when Bush and Nelson proposed their concepts for a combination of the world's total print materials via hypertext linkages and an on-line communications system the technology to support such a venture was either not yet invented or exorbitantly expensive. Netscape is made possible by the advent of reliable, cheap, high bandwidth telephone lines, reliable, cheap computer modems, and affordable and powerful desktop computers with good colour displays. While it is not the case that everyone in the world has access to these supports, it is the case that more and more people, especially in the developed world, are getting access to them. Hence, there was so much interest in Netscape that when the stock in the company that produces it was publicly listed it rose by more than $100 US in a single day on the stock exchange—not bad for a new and unknown product which had previously been distributed as a give-away on the NET.

The members of the Cyberleaming Design Forum decided that this project, the development of a catalytic tool for change in the organisation and support of learning, a software/ hardware based PLA or personal learning assistant, should be a priority for their further work. Accordingly, the members of the forum have indicated their willingness to participate in a 5 day, intensive, design and development workshop to create the templates and key concepts for this PLA. For now, the team has assigned the name Yoda to this new conceptual tool. Why Yoda? Yoda was the name given to the little green creature who mentored Luke Skywalker in the Star Wars Trilogy. Yoda was a tutor, a guide, and a support for the learning of young Skywalker in his search to become a jedi knight. This fictional character was based in part on the seminal work of Joseph Campbell (Hero With a 1000 Faces) in the area of mythology and its role in human culture. Campbell maintains that while our mythologies are incredibly diverse there are in fact underlying patterns which occur and reoccur frequently in most, if not all of them. Mythology is essentially about the human joumey, the struggles of life, the obstacles which must be encountered and bested, and the supporters and enemies which we meet along the metaphoric pathway. The Star Wars trilogy, although supported by all the high tech multimedia wizardry which LucasFilms could bring to bear, is a modern, perhaps 21st century mythic tale. It is comparable to the Homeric joumeys, or to Tolkein's Ring . Echoes of it can be found in the Walkabout of the aborigine, the Vision Quest of the native peoples of North America, and in many, many other cultural stories.

Hence, it seemed appropriate to assign the name Yoda to this project because what we seek to create is analogous to the helpful guide, the wise tutor, the sometimes mischievous aide, the patient teacher. This guide does not seek to control us, or to direct or even to stop us from making the sorts of mistakes from which we might learn. It often works by supplying not answers, but the right questions. It gently enforces a curriculum, but it recognises that ultimately the learner IS the curriculum. In a sense, this guide is the distillation of all the best teachers and tutors we ever had. It is a mentor, a master in a master-apprentice relationship.

The key question is do we have the knowledge and the technical know-how needed to

create such a system? It has long been apparent that we know far more about human learning and how to nurture it than we make use of in schools in any systematic fashion. Our problem in public education is not that we do not know what to do, but that we do not do what we know (or are not permitted to). There is a vast literature on cognition, learning styles, mentorship, cooperative learning, apprenticeship, reciprocal learning, and motivation. There is a vast literature on the sociology of learning. There is a large literature on the cultural bases of learning and on human development. Our challenge is not that there is no knowledge base for the project, but that we must avoid being overwhelmed by that huge plethora of information. What is needed is a powerful, simple, transformative metaphor. In the development of PageMaker Brainerd lifted the metaphor of the pasteboard into the realm of the computer screen. It worked because it was easy to understand and familiar, but the processes of the computer made it work in a new, more flexible and powerful way than ever it did in the physical world of actual glue and pasteboards. Yoda is the first step in the search for this metaphor. If we chose an electronic classroom, or library, or desktop we would likely constrain our thinking too much and make it too easy for existing organisations to assimilate, and ultimately dilute the power of the system we propose.

Thus, the Design Team has made a commitment to a further process of design. We have established a site on the WWW, hosted at SFU, and identified by the name Yoda. That Web Page will support our discussions over the months until the team can reconvene. It will also enable us to invite the participation of others. Netscape's designers succeeded by giving away the initial concept. We will seek the same path. But, in late spring or summer we will assemble again to take on the task of searching for the PLA.

And what does all this have to do with leadership? First, this is post-modern leadership. Second, if we succeed we will enable the generation of a new culture for the support of learning. That culture will not look like an industrial school any more than a modern assembly plant looks like the factories and mills of the industrial era. It may, strangely, look like a post-modern village in which learners learn in the context of an entire culture which nurtures learning as a life long quest. This is a culture in which everyone teaches and everyone learns. It is a culture in which learning is not divorced from acting and is richly contextualised. It is a culture in which in which people learn in teams, work groups, partnerships and as individuals, but the choice is theirs. It is a culture in which tools are available and where the use of these tools is modelled by masters in their use. It is a performative culture. It is so rich in information about learning and performance that the idea of an examination would seem deranged: every day is an examination, by the learner and his/her partners in the quest with the focus being on how to continue the work of learning, not how to weigh it. In this sort of environment everyone is sometimes a leader, everyone is sometimes a follower and all are always participants.

This is a visionary project. Appropriately so. When we bring together a group of visionary people we should expect nothing less than visionary results and this time, fortunately, we got it. The money was well spent. Yoda waits to be discovered.

Submitted on behalf of the Design Team,
Milton McClaren. March, 1996.

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Learner Contributions to Knowledge, Community, and Learning

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Chapter Title:
Learner Contributions to Knowledge, Community, and Learning

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Summary

The nature of work and learning in our knowledge-based society and economy requires active participation by individuals and groups in the construction of knowledge. Active construction of knowledge, participation in collaborative learning, and building on learners' interests and experiences outside of school are major threads in educational reform and new curriculum standards. In this chapter we will provide examples of student work that not only demonstrates their own learning as young "knowledge" workers, but also makes a contribution to their community, to the learning of others, and to the base of knowledge available on the Internet. We will construct a brief vision of learning, teaching, and knowledge-building in the future, assuming broad participation in these activities.

I. Introduction

Kris Abel, then a ninth grader at Patch American High School in Stuttgart Germany, attended the D-Day Commemoration Ceremony at Patch Barracks on May 26, 1994 with his grandmother Ms. Vernell Tanner, widow of a World War II veteran. Kris shared his first-hand experience in this historic and personal event with people across the world through his school's World Wide Web server with the help of teacher Pat Ridge. In Kris's essay he says: The appearance of the many veterans and their wives was one of the main attractions for me and my grandmother... They helped to personalize the event and make it official. With their solemn presence, the goals of the WWII Commemorative Command Program were achieved... From a personal perspective, I am proud to be related to a widow of a WWII veteran. My grandmother has been one of the great things that has helped me to understand the war pains of the countries involved in the war effort, and has given me even greater respect for the soldiers and their FAMILIES that experienced and paid the high price of war... I was the only one in the room under twenty and my grandmother was the oldest, so we attracted the attention of many... For the sake of the rest of us, D-Day + 50 must not be the end of the commemorative efforts of the world. Instead, it should be just the beginning of our respect and pride for the countries that were willing to risk a generation. We must show that their courage was not in vain, and that we understand the cost of our most deadly game. Kris Abel, http://192.253.114.31/Berlin/Introduction/Berlin.html

On June 1st, 1994, Patch American High School's "D-Day: The World Remembers" exhibit was announced on the National Center for Supercomputing Applications (NCSA) "What's New Page." In the following four months. more than 77,000 "visits" to its Web Server were registered. The visitors represented people from 39 countries on the globe (ranging from Taiwan to Russia to Israel to South Africa to New Zealand to Brazil to the USA.) The D-Day exhibit comprises work from a variety of sources such as the articles from the Stars and Stripes, to invasion maps from DOD historians, to newsreels of the landing, and speeches from Churchill and Truman. The main exhibits, however, are student and teacher essays/photos on the topics of D-Day and WW II. This exhibit continues to attract visitors and researchers from around the world. A sample of the materials at http://192.253.114.31/Berlin/Introduction/Berlin.html are:

- Report on a visit to Normandy during Easter Break 1995 by 9th grader. Angela Stevens;
- D-Day Commemoration Ceremony at Patch Barracks, Stuttgart Germany;
- World War II stories from Werner Dobner (a German-American who was a nine year old German boy on D-Day);
- The Patch High School JROTC field trip to Normandy;
- Retired soldier revisits Normandy, celebrates anniversary.

Like children (and learners of all ages) in many different places in the world today, the students at Patch American High School are seeing their unique local resources in a new light because they now have a worldwide audience for their work. They have the opportunity to create new knowledge and understandings by bringing their own unique perspective to local phenomena and information.

II. Schools as Learning Organizations in a Knowledge-Based Society

Once the principal source of wealth was natural resources. Then it was mass production. Today it is clearly the problem-solving capacity of the human mind-making products and tailoring services to the needs of people all across the globe. President Clinton, February 1994 speech to the American Council on Education

The changing nature of the world's economic system, the shift from an industrially-based society to an information-based society, is a pervasive factor driving educational changes for people of all ages. Society is shifting to the application of knowledge as the primary means of raising productivity. Phillip Schlechty (1990) argues, "In an information-based society, knowledge work is the primary mode of work, since information provides the primary means by which work is accomplished" (p.35). This places qualitatively different challenges to traditional companies. Innovative companies are responding to these challenges by transforming into, in Peter Senge's terms, "learning organizations":

...organizations where people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning how to learn together. Peter Senge (1990) p.3 Effective knowledge workers need to develop new higher level skills for accessing, selecting, manipulating, and representing information in a variety of formats. But this alone is not sufficient. As George Leonard said in 1968, "The highly technological, regenerative society now emerging will require something akin to mass genius, mass creativity, and lifelong learning" [Leonard, 1968]. That vision of a quarter-century ago is now reality. We are facing the challenge of large-scale knowledge production. The SCANS report says, "Modern work is just too complex for a small cadre of managers to possess all the answers" [SCANS, p. 16]. Workers, at every stage, or level, of a knowledge-based organization must contribute to the production of knowledge.

A learning organization is an organization in which people at all levels are, collectively, continually enhancing their capacity to create things they really want to create. Senge, as quoted in O'Neil (1995), p. 20 Schools, in turn, can respond to this challenge by taking seriously the Constructivist approach to learning. If children and teachers are engaged, collaboratively, in actively constructing their own knowledge, then schools are laying a foundation for the intellectual development of the knowledge worker. We can then extend the metaphor of a learning organization to the school system (cf. [Goldberg and Richards 1995].

III. Creating Knowledge in Networked Communities

In this section we explore examples of students and teachers contributing to the National Information Infrastructure by producing authentic products that represent their growing skills and knowledge.

A. Distributed Collaborative Inquiry

Collaborative inquiry in networked communities [Hunter 1993b] is a genre of learning, teaching, and knowledge-creating activity that illustrates many elements of educational reform and the knowledge-based society. Students in schools around the nation and the world gather data from their local environments, such as acidity of their rain water, quality of the indoor air, ozone, water quality in rivers and streams, biological indicators of changes in climate or pollution, effects of ultraviolet light on plant and animal life, species diversity, wildlife populations, migration patterns. They work in teams, often engaging parents and other local community members (such as scientists or engineers from a local water department) in their investigations. Each team is also part of a virtual community of scientists, students, and teachers in other schools; each school contributes to a collective database. Thus, that data base includes information from many different geographic locations. Through the networks, the students work together to aggregate, analyze, and interpret the data and share their discoveries and interpretations. The large database gives students the opportunity to recognize geographic patterns in the data, and provides a basis for comparing local data with data from other locations: data gathered locally has now more value because it is shared with a geographically distributed community.

There are hundreds of such collaborative inquiry projects and communities organized by teachers, experts, and students. Such projects help students move between the concrete, physical world they can touch and measure, and the electronic world of data they analyze to make and communicate powerful abstractions (exactly the kind of workers Reich (1991) characterizes as "symbolic analysts"). By learning to observe and describe their local physical and social world in ways useful to people in other locations, they learn to create knowledge, a role that in earlier times was enjoyed by only the small minority of scientists, inventors, writers, industrialists, or statesmen.

In such collaborative inquiry communities the learner has a real and responsive audience. This is highly motivating, just as it is motivating to any professional to get feedback from colleagues or audiences. The beneficial effects of this motivational aspect on learning have been studied in a systematic way by educational researchers including Margaret Riel who has studied children's writing [Riel, 1990] and Nancy Songer who is studying children's learning about weather and climate [Songer, 1994].

Global Lab

Over the past several years, teachers and researchers have begun developing tools and standard methods that help make virtual communities more productive. In the Global Lab project organized by TERC, teachers, high school students, and research scientists around the world study local and global ecological change. They use low-cost instruments and sensors such as ozonometers, ion-selective probes for soil and water monitoring, and field data loggers. To make meaningful scientific comparisons with sites from around the world, students and teachers must ensure that all factors influencing measurements are identical; when students in Moscow and Boston establish uniform guidelines to compare data, they learn the rigors and excitement of research. Students learn to investigate trends, compare their findings with local regulations and standards, and report and analyze data. The use of common instruments and software helps establish a common basis for collaboration. A peer review system, access to scientists for online assistance, and participation in collaborative research groups help develop quality research projects. Much work needs to be done in establishing mechanisms for maintaining quality of the knowledge produced.

Project GLOBE

Schoolchildren can often monitor many more sites for environmental studies than the professional scientific community could support, because they are located all over the world. This is the basic idea of the GLOBE

project initiated by Vice President Gore. Eventually, when large numbers of students and teachers have the appropriate tools and skills and network participation, they will fill an important role in areas such as monitoring atmospheric ozone, ultraviolet light, water and soil pollution, and bioindicators of global, regional and local change. The economic value of students' work has already been recognized by some of the companies that produce instruments and sensors. These companies value data collected in diverse circumstances and locations for testing their products; the companies provide the products to the community at reduced prices.

Such networked educational projects sometimes have direct and concrete benefits to the local school and neighborhood. One example is air quality studies conducted by Global Lab students in Pease Middle School in San Antonio, Texas, which resulted in improvements to the ventilation system of the school, and a new appreciation by parents and administrators of the contributions their young people can make. (Berenfeld 1993).

In Ann Arbor, Michigan, school children's data on water quality has been of such utility to the town that banks and the Chamber of Commerce have established low-cost loans for parents to purchae computers for children and companies are offering jobs for students to earn their own computers.

B. Systems Thinking

At Gonzaga High School in Washington D.C., students and their teachers are creating an Internet World Wide Web server on the subject of earth system science. Students use systems modeling software (STELLA II), data visualization tools (NCSA Image and NCSA Collage), and data from NASA databases to research earth system science topics. In each project the students conduct background research, create hypotheses, develop a strategy for data search, investigation, and testing, model the system qualitatively and quantitatively, and communicate their findings through a hypermedia document using NCSA Mosaic on the Internet. The teachers, Mike Keeler and Farzad Mahootian, are collaborating with teachers in other D.C. schools to form an exchange of such models and course materials through their Internet server.

C. Today's Students-Tomorrow's Citizens

If Chris Tanski and Seth Ladd are examples of tomorrow's workers, we all need to wake up and take notice. Both are high school students who have ALREADY been working to develop educational programs and materials for use by learners anywhere in the world. With some support from BOCES staff, and with multiple talents already in their possession, these young students have exemplified what happens when motivation and opportunity converge.

Chris Tanski

When eighth grader Chris Tanski first approached the Central NY Regional Information Center (CNYRIC) for an electronic mail account in 1993, he was supported by Mr. Kieran O'Connor, then his social studies teacher, now a CNYRIC Systems Consultant. Chris used his assigned email address to access and maintain discussions on topics such as golf and skiing. As he probed the local email system, the programming staff who had not encountered a motivated student on this system were worried. But their worry was unfounded. By tenth grade, Chris used his knowledge to move on to become a software developer with a local Cortland City company and, more importantly, a developer of Internet-delivered resources on a computer maintained by NASA to support learners across the world. As his skills developed, BOCES staff passed information along to Vicki Dick, Cortland's microcomputer support contact, about a national award for exemplary students. Chris was nominated by Vicki and selected as the winner of the high school division of the 1995 Technology Leaders Competition. In June, 1995, he returned to Cortland with a new Compaq portable computer after having addressed several thousand educators at the 1995 National Educational Computing Conference in Baltimore. (Contact Dan Lake about a video of Chris' speech.)

Chris has now moved to Pittsford, NY, where he is working on "Quest," NASA's K-12 Internet project. There, Chris has spent the entire summer implementing the advanced interactive features of the NASA server. "Quest" has several purposes: to help schools and teachers connect to the Internet; to point to useful resources

and information; and to assist teachers integrating the Internet into their classroom to support restructured math and science learning. Steve Hodas of NASA (hodas@nsipo.nasa.gov) commented, " We would like to connect teachers with NASA projects so that kids can see what real scientists do!"

Seth Ladd

When eleventh grader Seth Ladd was asked by his art teacher, Bob von Hunke, to join a team formed by Dan Lake to create a unique community resource to share with the world, he readily agreed. With the information from Bob von Hunke's computer-based ceramics curriculum, and with information supplied by the Everson Museum in Syracuse, NY, Seth and a team of students from the Fayetteville-Manlius High School Computer Graphics Club proceeded to create a resource available to anyone in the world studying ceramic objects and teaching how to create with clay. Called "ClayNet" this project is a model for the dissemination... by teacher-student-community member teams... of local resources that help represent our community's cultural pride. Using the opportunity and knowledge gained from this endeavor, Seth has formed his own consulting enterprise. He produces "Web pages" for area small businesses so that they may advertise on the Internet. He is also working during the summer to help automate some of the BOCES registration procedures used by teachers to subscribe to workshops held by the CNYRIC Learning Technologies Department. In the fall, he will continue adding Everson imagery to the F-M ClayNet project as part of an independent study effort working with other students.

Chris and Seth are prime examples of the idea that learning and work may be integrated into a profitable enterprise by motivated students. All they need are support and opportunity provided by their teachers... and in these two cases, support from OCM BOCES support staff working to create productive learning environments in our community.

D. Juneau, Alaska-Dzantik'i Heeni Middle School

Juneau Alaska has been networking all the schools in the district over the past year. The district-wide network is used in the schools to restructure the curriculum and meet the new Alaska standards. Collaboration is underway with the University of Alaska on a new Masters in Teaching program. The Dzantik'i Heeni Middle School is a Co-NECT demonstration site. The BBN Co-NECT design is a model for whole school change incorporating project-centered learning, portfolio assessment, cluster-based management, and, underlying and supporting this, a technological infrastructure. To support the cultural diversity of its students, Dzantik'i Heeni Middle School has an enduring theme celebrating diversity and invites community participation for one month of the year. The Dzantik'i Heeni Web server describes the schools, community, and school projects, including one where students are developing interpretive guides for two popular trails in the Juneau area and another called "Alaska Online" that is the product of an on-going curriculum project. The story below is about the Dzantik'i Heeni Middle School's work on the "Alaska Online" project.

> My grade eight students and I quickly entered the technology revolution last school year. Together we crafted a project we call, Alaska Online. The project goal is to educate people about our great state by publishing useful information on the World Wide Web.
>
> As our project grew and students developed working relationships with many community, state, and federal organizations. They became keenly aware that Alaska Online was very different from their previous classroom experiences. They clearly understood that our classroom was making a valuable contribution to the global computer network.
>
> Throughout the project students faced and overcame many challenges. Many of these students were at risk, lacked writing skills, and had lost pride in their community. In many ways this project helped them overcome these problems. Getting involved, learning about their community, taking on the responsibility of working with professionals in the Alaskan federal agencies, all gave them a sense of ownership, awareness of their abilities, and pride. One challenge was to fill the role of a professional writer. I recall the day a student asked me, "Do I really have to rewrite this piece again?" My response was, when we write for a potential

audience of 30 million people. we don't want to spell things incorrectly. He smiled and went to draft another paper.

Dzantik'i Heeni Middle School-Teacher. Devon Jones

IV. Foundation for Participation

The following characteristics of active learning provide a foundation for a participatory vision of education:

- a closer relationship of learning to the real-world context of problems and projects;
- working collaboratively with peers and mentors;
- closer relationships between people inside schools and outside in the "real world";
- working in a hands-on mode with the physical world, in addition to symbols and words;
- learning something just at the time it is needed to solve a problem or complete a project, rather than in a preset curriculum sequence;
- learning in an interdisciplinary context, rather than always separating subjects into isolated topics;
- working on a problem in depth, rather than covering many topics superficially;
- teachers being guides and mentors and learners too, rather than only dispensers of knowledge;
- constructing one's own knowledge rather than memorizing facts from authorities;
- working on projects and problems of intrinsic interest to the learner or a group of learners, rather than learning what everyone else of the same age is expected to learn at the time;
- building learning experiences on the learning one does throughout life, rather than only on "school" subjects;
- basing assessment on performance of real tasks rather than artificial tests;
- using the real tools for intellectual work that are used in the workplace, rather than oversimplified textbook techniques;
- working directly with people from other places and cultures, rather than only learning about other places indirectly through books.

Creating such a foundation will be a collaborative effort or partnership among administrators, university faculty members, community, business, labor and political leaders, as well as parents, teachers, and students. The central value of internetworking to support learning and teaching for our changing world, is that internetworking can support or enable authentic learning experiences and cross-institutional collaborations needed for the reform of education. [Hunter, 1993a]. When learners and teachers contribute to the information infrastructure by participating in virtual communities and by setting up information services on the networks, their experience has many of the visionary qualities summarized above. The key characteristic of internetworking that enables this kind of experience, is that the people who use the Internet are creating and exchanging knowledge, rather than passively receiving someone else's information. There is a danger that the networks could be used to transmit and amplify traditional and outmoded elements of schooling instead of providing a mechanism for the transformation to lifelong learning needed by all citizens. Many well-intentioned efforts to apply technologies to schooling (often in the name of "reform") still assume such factory-era constraints as segregation of learners by age, a sequential curriculum, everyone learning the same thing at the same time, learning activities confined to the school or classroom, no participation of parents in the learning activities of their children, knowledge predigested by experts, teacher as authoritative knowledge base, memorization of facts today for use in later years, subjects isolated by disciplines, same roles for all teachers, right answers to all test questions, students following procedures written by outside authorities, class periods too short to think in, teacher as only audience for students' work, abstractions separated from experiential context.

The way in which we shape and engineer the technology, tools, organization of knowledge and virtual communities on the expanding Internet information infrastructure, will directly impact on the potential productivity, roles, and equity of opportunity of young people in both near and distant future, and thereby will affect the kind of society we evolve into.

These examples of learner and teacher contributions to the current Internet provide a glimpse of what is

possible with today's technology, infrastructure and organizational arrangements. However, the value people can contribute and the value they get, is limited by the local networking infrastructure, tools and services on the nternet, and by the free-for-all nature of most current virtual communities' interactions. Most contributions wind up as flotsam and jetsam on a vast chaotic sea of email and newsgroup messages and Web pages-with little order, discipline, quality assessment, structure, retrievability, review, or aggregation. There has been considerable recent progress in developing software that makes it easier to get onto the networks and discover information from personal computers. As more people attempt to participate and more virtual communities are formed, we are gaining more insight into the kinds of tools and services needed for full participation including user construction of knowledge and information services. The Clinton-Gore Administration's National Information Infrastructure (NII) plan recognizes the importance of broad-based participation in the development of the Internet and the evolving nature of the NII:

> ..the NII will be of maximum value to users if it is sufficiently "open" and interactive so that users can develop new services and applications or exchange information among themselves, without waiting for services to be offered by the firms that operate the NII. In this way, users will develop new "electronic communities" and share knowledge and experiences that can improve the way that they learn, work, play, and participate in the American democracy. (NTIA, 1993)

V. Vision of Large Scale Participation

Many factors affect the value of contributions made by individuals and groups. In the National School Network Testbed BBN is collaborating with over 100 organizations who are exploring models for leveraging Internet access for educational innovation. [Hunter, 1995]. This research has made it clear that scaling up is not a simple matter of physically connecting more people and organizations to the Internet. Rather, scaling up has many dimensions-technical, organizational, educational, economic, and social. What is to be maximized, overall? Is it the number of people who have access to the networks? Is it the ease with which these people can learn to take advantage of the resources? Is it the educational opportunities they have had, that make them competent managers of information and creators of knowledge? Is it the contributions they have an opportunity to make? Is it the accessibility of their contributions to others, within and outside of their own local and virtual communities? Is it the social creativity and solution to problems that results from this synergy? Is it the effectiveness of a new economy based somehow on individuals' (or groups') contributions to knowledge?

If internetworking and the National Information Infrastructure is to support the transformation outlined here, then "scaling up" has to mean all these things, and more. Decisions made by government agencies, corporations, and communities about investment in infrastructure and educational reform will take into account the mechanisms needed to make progress on all of these fronts. The following four-part vision [of a school as a learning organization] may help to guide our decision making, particularly with regard to elementary and secondary education in the future:

1) **Responsibility for one's learning will be shared by all.** The pace of change is too fast for individuals to depend totally on others to structure their learning and information for them; pre-planned courses, textbooks, teacher training programs, technical support staff, and the like, may not always be available to meet an individual's particular learning need. New curriculum frameworks, instructional materials, assessment and testing schemes, and teacher training programs will take into account these increased responsibilities for information management and knowledge creation. Similarly, software and networked information services for educational purposes will be designed with the assumption that people will be taking on these responsibilities. For example, "ease of use" is a commonly called-for characteristic of networks, information services, and software, but there is always a trade-off to be made between ease of use and complexity or functionality. In the quest for "ease of use" of information and tools in the Internet, we must be careful not to exclude people from participating in the more complex and rewarding tasks of constructing knowledge. Students will learn how to deal with phenomena that are new and more complex than they are "ready" for, and get opportunities to make sense out of situations before they understand all the first principles.

2) **Responsibility for teaching and mentoring will be shared more widely than in the past.**

Classroom teachers will not be expected to have expertise in all the areas of knowledge their students are encountering. The communications networks will support teaching by people whose primary work is not formally teaching, but who have expertise in industry and other public sectors. Incentives to perform these part-time and out-of-school teaching and mentoring roles will be devised. Communities and school districts making an investment in new curricula or technology should not attempt overlay such innovations on outmoded methods of operation of schools; rather they will look broadly for new opportunities to engage people in nontraditional roles.

3) **Learning is seen more as a process.** Intelligence is recognized as diversified, and authentic assessment tells us to look at it in context. Teachers and administrators are also learners. In that role they are typical learning organization managers. They are mentors, they guide, provide access to resources, facilitate.

School itself is more an integrated system. School is divided into smaller clusters, where teachers and students and their families get to know one another, and form a sense of community. Collaborative groups work on meaningful projects, and just in time seminars and workshops provide support for the projects.

4) **Educational reforms will evolve in synchrony with the evolving information infrastructure.** As a society, we are working hard on "educational reform" at the same time that we are evolving new information infrastructure. There is a danger that enormous efforts now put into educational "reforms" will turn out to be irrelevant to the circumstances of learning and working in a networked, knowledge-creating society. Current investments in reformed curriculum frameworks, standards, assessments, teacher inservice programs, and the like, should both take advantage of networking to reduce industrial-age constraints; at the same time they can contribute vitally to the evolving information infrastructure to the learning benefit of everyone.

VI. References

Berenfeld, Boris (1993). A moment of glory in San Antonio. *Hands On!* Fall 1993 Vol. 16(3). TERC, 2067 Massachusetts Avenue, Cambridge, MA 02140.

Goldberg, B. and Richards, J (1995). "Leveraging technology for reform: Changing schools and communities into learning organizations." *Educational Technology*, September, 1995: 5-16.

Hunter, Beverly (1993a). Internetworking: Coordinating technology for systemic reform. *Communications of the ACM*. May 1993, pp. 42-46.

Hunter, Beverly (1993b). Collaborative Inquiry in Networked Communities. *Hands On!* 16(2). Cambridge, MA: TERC Fall 1993.

Hunter, Beverly (1995). Internetworking and Educational Reform: The National School Network Testbed Partnership. *Proceedings of the International Internet Conference*, Honolulu June 1995.

Leonard, George B. (1968). *Education And Ecstasy*. Delacorte Press, New York. NTIA (1993).

The National Information Infrastructure: Agenda for Action. Washington: Dept. of Commerce, NTIA.

O'Neil, John (1995). On schools as learning organizations: A conversation with Peter Senge. *Educational Leadership*, April 1995: 20 - 23.

Reich, Robert (1991) *The Work of Nations.: Preparing Ourselves for 21st Century Capitalism*. New York: Vintage Books.

Riel, Margaret (1990). Cooperative learning across classrooms in electronic Learning Circles. *Instructional Science*, 19: 445-466.

Schlechty, Phillip C. (1990). *Schools for the 21st century* . San Francisco: Jossey Bass.

Senge, Peter (1990). *The fifth discipline: The art and practive of the learning organization* . New York: Doubleday.

Songer, Nancy (1994). Knowledge construction through global exchange and dialogue: A case of kids as global scientists. submitted to the *Journal of the Learning Sciences* .

The Secretary's Commission on Achieving Necessary Skills (SCANS,1992). *Learning a Living: A Blueprint for High Performance* . Washington, DC

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ED HOME UP [Table of Contents]

Francis M. Duffy

10

Supervising Schooling, Not Teachers

Traditional supervision assumes that if only enough teachers improve, the district will also improve. Knowledge Work Supervision turns that approach on its head by suggesting that the way to improve schooling is to focus on the performance of the entire school system.

Teachers are knowledge workers. A term first coined by Peter Drucker, *knowledge work* is white collar work with knowledge as the foundation of job performance. Although teachers use computers, follow predesigned curriculums, and use intricately designed lesson plans, their primary tool is the knowledge inside their heads.

Arian Ward (1994), a leader in business engineering, asserts that knowledge takes two forms: rules-based and context-based knowledge. Rules-based knowledge follows procedures that yield one correct answer to a specific problem. Context-based knowledge takes the form of wisdom, experience, and stories—not rules—and it varies with the context of the problem being addressed. Most knowledge, according to Ward, is context-based. Because effective teaching varies with the context of a particular classroom, teachers are knowledge workers using context-based knowledge. These simple facts are often overlooked in the best efforts of administrators to transform their school districts into high-performing learning organizations.

Blanket prescriptions tell us why schools need improving, but rarely tell us how to actually improve them.

When educators talk about school improvement, they often propose solutions like outcomes-based education, extended school years or school days, 90-minute block periods, school-based management, charter schools, and democratic learning communities. These one-pill-cures-all prescriptions tell us why schools need improving, but rarely tell us how to actually improve them.

One reason that administrators fail to successfully improve schooling is their adherence to an individual approach to supervision. The current supervisory paradigms involve working with individual teachers to bring about improvement in the school or school district. I maintain a paradigm shift is required. Supervisors must take a systemic approach to school improvement, keeping in mind the teachers' roles as knowledge workers. I call this new paradigm Knowledge Work Supervision.® Figure 1 describes the proposed paradigm shift.

Teachers as Knowledge Workers

My own experience as a high school teacher illustrates the complexities of being a knowledge worker. I would enter the classroom with learning objectives in mind and a lesson plan in hand. But once I started the class, my mind would race, and new examples of the points I was trying to make would pop into my head. Students would ask questions that would repeatedly take me off course. Looking at the clock, I'd realize class was almost over. Before closing I would make one last point triggered by a student's question during the first minute of class—a full 44 minutes earlier.

Kind of nonlinear, isn't it? There's no research evidence suggesting this kind of knowledge work can be improved using traditional supervisory methods.

In a school district, the linear work process that the teacher works within is the instructional program, kindergarten through 12th grade. You improve your instructional program by examining it, grade by grade, to identify where mistakes are made or where the potential for mistakes exists. Then you take actions to correct the mistakes or eliminate the possibility of making them. Improving nonlinear knowledge work, on the other hand, requires different actions. Remember that knowledge work occurs primarily inside the heads of teachers and is manifested as classroom teaching behavior. In regard to improving knowledge work, Drucker (1991) says:

> In knowledge and service work, however, the first questions in increasing productivity—working smarter—have to be "What is the task? What are we

trying to accomplish? Why do it at all?" The easiest, but perhaps also the greatest, productivity gains in such work will come from defining the task and especially from eliminating what does not need to be done (p.72).

Once you answer Drucker's questions, then the broad actions needed to improve knowledge work are to

- Improve the quality and timeliness of key information teachers need to teach effectively;
- Assure that teachers interact with key people with whom they should be exchanging critical information;
- Provide teachers and key people with a variety of structured, semistructured, and informal forums for exchanging information (for example, structured workshops, brown bag lunches, or national conferences);
- Examine and improve any devices (for example, computers), work procedures (lesson planning), and organizational functions (for example, administration and supervision) that support teaching (adapted from Pava 1983).

Although Knowledge Work Supervision focuses on improving the entire school system, the model does have methods for supervising and appraising the performance of individual teachers. These are listed in Figure 1 under "Ways of Improving Individual Performance Levels." Six methods are recommended. Remember, however, that with Knowledge Work Supervision, appraising individual performance is not the path to school improvement. Knowledge work, because it occurs inside a professional's head, cannot be supervised directly. This stands in direct contrast to current supervisory methods in schools.

Traditional Supervision Cannot Improve Schooling

There are two leading models of school supervision. One, which dominates the literature and is seen occasionally in practice, is clinical supervision (Cogan 1973, Goldhammer 1969). Clinical supervision, as originally conceived, is a five-phase process: pre-observation conference, observation, analysis and strategy, postobservation conference, and postconference analysis. Supervisors observe classroom teaching, make notes following prescribed methods, analyze the observation notes, and share the results of the observation with the teacher, assuming that the feedback will help the teacher improve his or her performance.

Knowledge work, because it occurs inside a teacher's head, cannot be supervised directly.

The other model, found overwhelmingly in practice and disdained in the supervision literature, is performance evaluation. As frequently experienced by teachers, performance evaluation is a twice-a-year surprise observation of classroom teaching. Supervisors use evaluation forms containing several categories of behavior that are assumed to represent effective teaching. Supervisors often fill out the forms during the observation. The results are used for personnel actions (for example, to grant tenure or for merit pay).

Although these approaches differ, they have one striking similarity: they both examine the behavior of individual teachers. The underlying, unstated assumption of both approaches is that if only enough teachers improve their teaching, then the overall performance level of the school district will also improve. Even though we understand that school districts function essentially as systems, we persist in trying to improve schools one teacher at a time.

I propose linking school improvement to instructional supervision. School improvement can become a permanent, ongoing organizational function by replacing traditional instructional supervision with a supervision-for-school-improvement function. The focus of supervision then shifts from scrutinizing the behavior of individual teachers to examining and simultaneously improving a district's (1) work processes, (2) social architecture, and (3) relationship with its broader environment. This combined function, which I call Knowledge Work Supervision, will transform school districts into high-performing learning organizations.

What It All Means

Three key groups of players power Knowledge Work Supervision: a districtwide Steering Committee, Redesign Management Teams, and a Knowledge Work Supervisor. The Steering Committee provides strategic leadership for organizational learning. Members include a senior administrator and a building principal and a teacher from each level of schooling (elementary, middle, and secondary). The Steering Committee aligns school improvement actions with the district's overall mission and vision.

Redesign Management Teams (currently existing in many schools as

school improvement teams) provide tactical leadership. These teachers and administrators from each level of schooling develop specific proposals for redesigning their schools and send them to the Steering Committee for review and approval.

A Knowledge Work Supervisor is an administrator, supervisor, or teacher trained to serve in this new role and provides daily coordination of activities. Some school districts may choose to establish and train a cadre of Knowledge Work Supervisors. In addition to coordinating the entire improvement process, the Knowledge Work Supervisor manages the invisible but real boundaries between various parts of the organization—that is, the boundaries between grade levels, levels of schooling, clusters of schools and the larger district, and between the school district and the community. It is in these boundaries that information is lost or distorted, children fall through the cracks, program goals mutate, necessary connections between grade levels disconnect, and good intentions fall short. The Knowledge Work Supervisor manages these boundaries by developing high-powered communi-

FIGURE 1

Direction of the Proposed Paradigm Shift

Paradigm Attributes ▼	From → *Traditional Paradigms*	→	To → *Knowledge Work Supervision*
Underlying Philosophy	Changing the behavior of individual teachers improves the entire organization	→	Changing the entire organization improves individual teachers
Focus	On behavior of individual teachers	→	On the school's overall performance
Organizational Unit Within Which Supervision Occurs	Within individual schools	→	Within clusters of interconnected schools inside the district
Core Methods	Classroom observation for clinical supervision and performance evaluations	→	Assess and continuously improve all of the following for the life of the organization: 1. The school system's relationship with its environment 2. The work processes: linear work and knowledge work 3. The social architecture, including motivation, job satisfaction, skills, and quality of work life
Key Players	Principal Instructional supervisor Peers	→	Districtwide Steering Committee providing strategic leadership Redesign Management Teams providing tactical leadership Knowledge Work Supervisors providing overall coordination and process management
View of Teachers	Colleagues needing assistance; or employees needing to be evaluated	→	Semiautonomous knowledge workers; stakeholders in the organizational improvement process
Ways of Improving Individual Performance	Formative/summative evaluation Inservice training Coaching Clinical supervision	→	Formative evaluation Self-directed inservice training Coaching Clinical supervision (on individual basis) Competency Modeling Performance Technology

cation strategies that promote organizational learning.

In some organizations, boundary management is accomplished by creating liaison roles. Mohrman, Cohen, and Mohrman (1995) describe several liaison roles commonly found in organizations. Adapted for school districts, these roles are liaisons between school buildings; with professionals within a school building; with students, parents, and community groups; with upper management; and with professional organizations (p.163).

Nothing is sacred—everything is subject to reengineering.

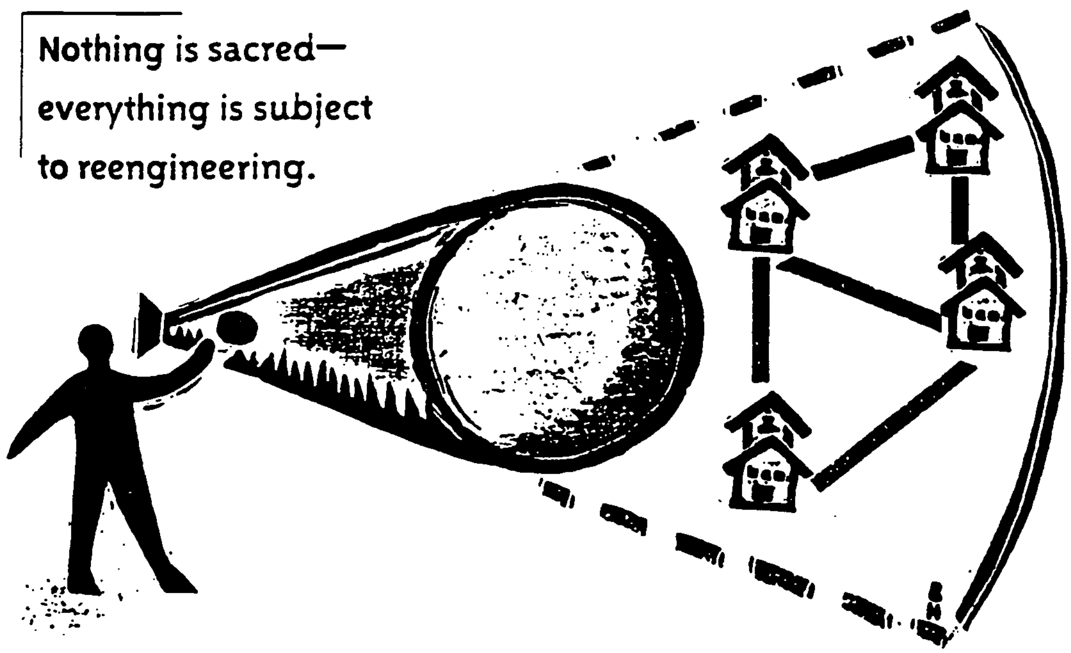

Illustration by Becky Heavner

The Knowledge Work Supervision model capitalizes on a school district's collective knowledge to provide educational services of value to *all* students and parents. This approach has four phases.

In Phase 1, *Preparing*, the Steering Committee sets the stage for redesigning the school district.

In Phase 2, *Redesign for High Performance*, a Redesign Management Team and a Knowledge Work Supervisor assess the work processes and social architecture of the district and develop specific redesign proposals.

In Phase 3, *Permanence and Diffusion*, the Redesign Management Team and Knowledge Work Supervisor work to make improvements permanent within the schools that started the process and, later, to spread those improvements throughout the district.

In Phase 4, *Continuous Improvement of Schooling*, the supervisor, team, and committee continue to improve schooling after the entire district is transformed, with the goal of making incremental improvements by applying principles of quality management.

After a predetermined period, Phase 4 ends and the process returns to Phase 1. Thus, organizational learning and renewal through Knowledge Work Supervision continues for the life of the school district.

Supporting Theories on Organizational Improvement

Whenever I share this approach, at least one person asks, "Who's using this?" I imagine Cogan, Anderson, and Goldhammer faced this question when they first proposed clinical supervision. The answer is "No one, yet!" The model is mired in a quandary: because it's new, no one is using it, and because no one is using it, no one wants to try it.

To help people get over its "newness," I explain that although the model itself is new, its components are not, and many are currently being used in schools. For example, Joyce and colleagues (1983) describe a long-term school improvement process with (1) refinement, (2) renovation, and (3) redesign, and they refer to school improvement teams, found today in many school districts. School districts also regularly assess their communities' expectations and apply principles of continuous improvement (Joyce 1980).

To design Knowledge Work Supervision, I bundled tested organizational improvement methods (taken from socio-technical systems design, quality improvement, reengineering, and organization development) with innovative ideas for improving knowledge work

in school districts. A summary of these ideas follows.

Socio-Technical systems. Socio-technical systems (STS) design theory suggests that organizations are complex systems with components that interact with one another (Emery 1959; Trist 1965; Pasmore 1988). The system functions by converting *inputs* into *outputs*. Inputs are human, financial, and technological resources that result in products or services (outputs) being delivered to a customer. The attitudes, knowledge, and skills of people (the social system) affect the work they do. To improve, managers and employees require *feedback* (that is, an evaluation of the quality and timeliness of a product or service).

According to STS design practice, the way to improve a *system* is to examine and improve three sets of organizational variables that affect the quality and timeliness of the final product or service: an organization's work processes, its social architecture, and its environmental relations. Further, improvements in these areas must be made simultaneously—an STS design principle called *joint optimization*.

A school district can apply the principle of joint optimization by using Knowledge Work Supervision. In using this supervision-as-school-improvement model, practitioners assess the instructional program and teachers' access to high-quality knowledge (the work process); the job skills teachers need, their job satisfaction, and their motivation (that is, the social architecture); and the district's relationship with its broader environment (environmental relations). The assessments result in specific proposals to redesign these three areas simultaneously (following a carefully planned schedule).

TQM. Total Quality Management is another theory guiding Knowledge Work Supervision. This philosophy leads us to rethink how organizations operate. Its core beliefs are that quality is the goal of effective organizations and that customers judge quality.

W. Edwards Deming, the father of TQM, believed quality shortcomings rest with management and management systems (1982). The reason managers do not use TQM principles effectively is that they lack an understanding of *how to change* traditional, bureaucratic organizations. According to Sherwood and Hoylman (1992), fundamental and enduring improvements in quality come *only* with fundamental changes in the way an organization is designed, with changes in the way people are viewed and managed, and thus with changes in the way work is thought of and performed.

It is your school district's lifelong journey of organizational learning and renewal that will improve its organizational performance.

Reengineering. Developed by Michael Hammer and James Champy (1993), reengineering is a popular improvement process in the business world. A key principle is the *clean slate* approach to redesigning work processes. This principle says that when it comes to organizational redesign, nothing is sacred—everything is subject to reengineering.

Reengineering examines only the work processes of an organization. It does not try to "reengineer" the social architecture. Because of this, I regard this model as flawed because I believe the work processes and the social system must be redesigned and improved simultaneously. Nevertheless, I extracted and modified the clean slate principle from business process reengineering as follows: If a process or a component of a school district is working well (as documented with evaluation data), then do not redesign it. However, examine and improve everything else—including the way the district's administrative structure supports classroom teaching (the core work process of all school districts). In some cases, the only way to improve a process will be to wipe the slate clean and start all over again.

Organization Development. One significant concept from organization development incorporated in the model's design is the idea of the "learning organization." Chris Argyris and Donald Schön (1978) wrote much about this concept. Peter Senge (1990a) called learning organizations places where people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspirations are set free, and where people are continually learning how to learn together (p. 1).

David Garvin (1993) describes a learning organization as "an organization skilled at creating, acquiring, and transferring knowledge, and at modifying its behavior to reflect new knowledge and insights." The hallmarks of a learning organization, according to

Senge (1990b), are (1) systematic problem solving, (2) experimenting with new approaches, (3) learning from experience, (4) learning from the experiences of others, and (5) transferring knowledge quickly and efficiently throughout the organization.

A school district can create the above characteristics of a learning organization by using Knowledge Work Supervision. During Phase 3 of the process, the Redesign Management Team and the Knowledge Work Supervisor develop specific redesign proposals to build in systematic problem solving, freedom to experiment, opportunities for teachers and administrators to exchange information, and methods for transferring knowledge throughout the school district. Specific designs to achieve these characteristics of a learning organization are tailored to fit the unique requirements of each school district. There is no prescribed design.

Knowledge Work Supervision can transform your school district into a high-performing learning organization, whereas traditional supervision cannot transform entire school districts into high-performing learning organizations no matter which method you use. Knowledge Work Supervision takes time, however, because it is to be used continuously for the life of your district. As the organizational improvement literature points out, some of the most important improvements in organizations don't happen until several years into their transformation (Kotter 1995). Yet some school administrators expect quick change carried out as a singular event. Worse, schools often launch improvement initiatives, only to scrap them because of the vagaries of transient top administrators seeking to put their mark on each district they enter.

School improvement must be a permanent, ongoing organizational function.

If applied consistently and with patience, Knowledge Work Supervision will move your entire school district toward higher levels of performance. Of course, even if you adopt this approach, your district will never perfectly achieve its vision of excellence. Yet because you repeat this cycle for the life of your organization, your district will move continuously toward its vision. It is your school district's lifelong journey of organizational learning and renewal that will improve its organizational performance. Nothing less will do it. ■

References

Argyris, C., and D. Schön. (1978). *Organizational Learning*. Reading, Mass.: Addison-Wesley.

Cogan, M. L. (1973). *Clinical Supervision*. Boston: Houghton-Mifflin.

Deming, W. E. (1982). *Out of Crisis*. Cambridge, Mass.: MIT Press.

Drucker, P. F. (1991). "The New Productivity Challenge." *Harvard Business Review* 69, 6: 69–79.

Emery, F. E. (1959). *Characteristics of Socio-Technical Systems*. London: Tavistock Documents #527.

Garvin, D. A. (July/August 1993). "Building a Learning Organization." *Harvard Business Review*, 71, 4: 78–91.

Goldhammer, R. (1969) *Clinical Supervision: Special Methods for the Supervising of Procedures*. New York: Holt, Rinehart and Winston.

Hammer, M., and J. Champy. (1993). *Reengineering the Corporation: A Manifesto for Business Revolution*. New York: HarperCollins Publisher.

Joyce, B. R. (1980). "The Continuous Process of School Improvement: Lessons Learned from the Past." (ERIC Document Reproduction Service No. ED243879).

Joyce, B. R., R. H. Hersh, and M. McKibbin. (1983). *The Structure of School Improvement*. New York: Longman.

Kotter, J. P. (March/April 1995). "Leading Change: Why Transformation Efforts Fail." *Harvard Business Review* 73, 2: 59–67.

Mohrman, S. A., S. G. Cohen, A. M. Mohrman, Jr. (1995). *Designing Team-Based Organizations: New Forms for Knowledge Work*. San Francisco: Jossey-Bass.

Pasmore, W. A. (1988). *Designing Effective Organizations: The Socio-Technical Systems Perspective*. New York: Wiley & Sims.

Pava, C. H. R. (1983). *Managing New Office Technology: An Organizational Strategy*. New York: The New Press.

Senge, P. (1990a). *The Fifth Discipline*. New York: Doubleday.

Senge, P. (1990b). "The Leader's New Work: Building Learning Organizations." *Sloan Management Review* 32, 1: 7–23.

Sherwood, J. J., and F. M. Hoylman. (March 1993) "The Total Quality Paradox." *Journal for Quality Participation* 16, 2: 98–105.

Trist, E. L., G.W. Higgin, H. Murray, and A. B. Pollack. (1965). *Organizational Choice*. London: Travistock Publications.

Ward, A., in T. A. Stewart. (October 3, 1994). "Your Company's Most Valuable Asset: Intellectual Capital." *Fortune* 30, 7: 68-74.

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BY SETH J. ITZKAN

Assessing the Future of Telecomputing Environments

Implications for Instruction and Administration

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The tools of technological forecasting and assessment provide insight into the online world that lies ahead.

No educational administrator can fail to notice the rumblings of change coming at the hands of telecomputing technologies. These technologies include audio-visual computing, the Internet, Information Highways, and others. But what will their lasting effects be, and how are planners to anticipate them? The tools of technological forecasting and assessment can provide helpful insights. Although these tools have traditionally been the province of business and government, it is now essential that they find a home in the academic professions.

There are four methods commonly used for a technology forecast and assessment. These are (1) expert opinions, (2) leading indicator analysis, (3) trend analysis, and (4) diffusion theory. Each of these provides a unique perspective, revealing the significance of the technology, its rate of change, and the process of its adoption.

Expert Opinion

Expert opinion is the first and easiest method of a technical forecast. It lets one know what the leaders of the time have to say about the topic on hand. It is a temperature gauge of current thinking. In regards to telecomputing, the temperature gauge reads "hot." Experts are promising comprehensive connectivity and global multimedia telecomputing between schools before the turn of the century. In a speech to the World Future Society last July, Raymond Smith, CEO of Bell Atlanta stated.

> "Today we are wiring schools throughout our region with interactive video, tomorrow a real time global interactive university...sooner than you'd ever believe."

In mirroring this rhetoric, Vice President Al Gore has challenged the telecommunications industry to "connect all of our classrooms, all of our libraries, and all of our hospitals and clinics by the year 2000." This is powerful language from powerful people. In as much as one is a company executive and the other a politician, the school administrator may be skeptical, but must not dismiss the significance of these statements. On these comments alone, prudence would suggest serious investigation into school models that support comprehensive, national, and international connectivity.

Leading Indicators

Expert opinion, however, means nothing if the evidence is not there to corroborate it. The leading indicators are those phenomena that are "signs of things to come." In regards to emerging telecomputing technologies, most applications are marketed toward the business community, and so their significance for education is not always apparent. Nonetheless, we are seeing that the time it takes for a technology to move from the domain of business to the domain of education is shrinking rapidly. Many emerging technologies in the business world today are only a few years from being an emerging technology for education. These are thus leading indicators. There are three kinds of leading indicators to investigate, those regarding future computing, future telecommunications, and future applications:

Future Computing

- Audio-visual Computing—the merging of analog and digital signals into a single data format. This allows computer and communications operations to be readily intermixed on a workstation. Examples are the new MAC AVs, and the Silicon Graphics Indy. Each is capable of seamless handling of video and audio in a traditional computing environment.

PowerPCs—new line of RISC-based computers from Apple and IBM. These will be the first generation of mass-marketed computers specifically made to handle the intensive memory and computational requirements of real-time multimedia. Audio and visual signal manipulation will no longer be an incapacitating strain on the system. Traditional computing applications, such as spreadsheets and document processors will run five to 10 times as fast as they do on today's top 486 and Quadra models.

Personal Digital Assistants (PDAs)—computer notepads, used as address books, schedulers, and memo keepers, but also sporting such advanced features as handwriting recognition, voice activation, and even E-mail, fax, and cellular capabilities. Future models will be targeted for wider markets, including education. PDAs with CD-ROM capability is a plausible achievement by decade's end.

Future Telecommunications

ISDN—the Integrated Services Digital Network. Primarily this is an advanced form of phone service that will also offer video capabilities. Future applications will include basic video-phone conferencing and data transfer over a single conduit. The significance for schools is that "phone service" will affect curriculum. It forces academic and facilities considerations to be discussed under a common umbrella.

ATM—Asynchronous Transfer Mode. A new networking technology designed specifically to meet the demands of real-time, high fidelity audio and visual telecomputing. ATM unites the services of data, voice-telephone, and videoconferencing into a single network. Bandwidth may be up to 2.4 Gigabytes per second—2,000 times the speed of standard Internet connections. At such speeds, the Grolier encyclopedia could be downloaded in seconds.

Internet/Information Highways—the emerging infrastructure of America's telecomputing environment. The Internet is the computer network that now links hundreds of thousands of schools, libraries, and research institutions around the world. The Information highways are the future manifestations of technologies like the Internet, except that they will provide commercial and entertainment services and likely be accessed through interactive television. Initial services provided will be fairly pedestrian, such as home shopping, movies on demand, and choice of camera angles for sporting events. But, in time, powerful educational applications should also be expected, such as the capability to receive home instruction from the college or university of one's choice, or to have a group conversation (through your T.V.) with classmates.

Future Applications

- Video Servers—devices which convert analog T.V. signals to digital and that work as LAN-based storage for video-mail, news reels, or other video segments. Applications for schools include online video libraries, providing, for example, retrieval of famous speeches, inaugural addresses, or presidential debates.
- Distributed Multimedia—the integration of multimedia into distributed computing environments. A sample application is the inclusion of voice with E-mail. For schools, this could bode well with foreign language partners, who may include their speaking as well as writing.
- Virtual Meetings—the addition of voice to online keyboard conferences. In virtual meetings, written and spoken comments are archived together and can be reviewed and responded to. Anonymous voting and real-time document sharing may also be included. For schools, this will be the logical evolution of the Internet Relay Chats (IRCs) which are increasingly common today. Online guests will be able to give both typed and spoken communications to students through the computer network.

We are seeing that the time it takes for a technology to move from the domain of business to the domain of education is shrinking rapidly.

Trend Analysis

Once the leading indicators have confirmed that changes are on their way, the rate must be determined. Trend analysis is the quantitative assessment of the growth or decline of phenomena over time. Concerning the adoption of instructional telecomputing, the trends of immediate interest are the growth of personal computers and networking in schools. How widespread are these phenomena, and how fast is their proliferation?

Microcomputers in Schools

A quantitative trend assessment of microcomputer growth in schools is illustrated in Figure 1. Microcomputer installations have grown linearly in the last 10 years (not exponentially as some might have predicted). A linear forecast then, of this present trend, would put us as 4.3 million installed PCs in schools by the year 2000. The significance of this is the *microdensity*, or the ratio of students to computer. Extrapolation of current trends suggests a microdensity of 10 by the turn of the century. This is factored over all grades, so at the middle and high school levels the ratio might be even lower.

Networks in Schools

Network growth at the K-12 level is not a phenomenon that has a great deal of history. Several recent studies suggest there are more than 100,000 E-mail accounts on state educational networks (Abrams, 1993) and ap-

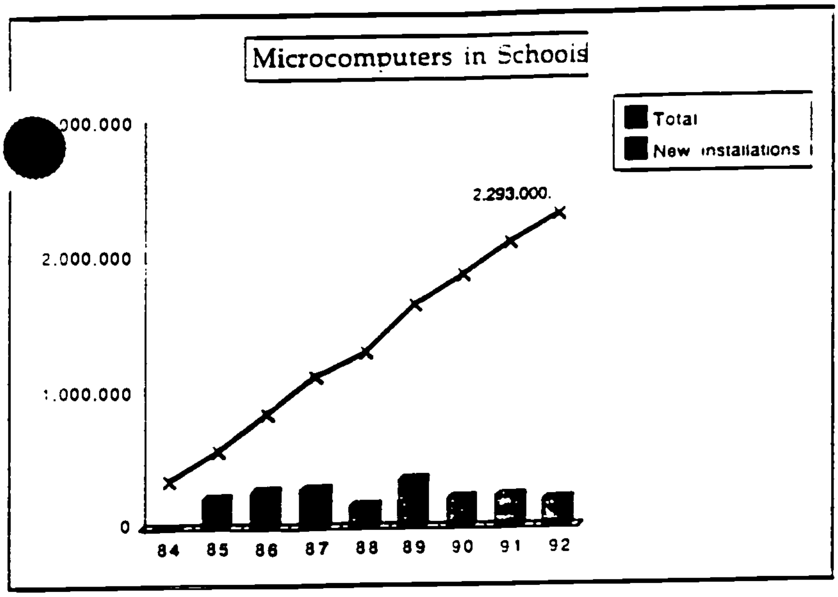

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Figure 1. Microcomputer Growth in Schools, 1984-1992
Source of data: Quality Education Data, Denver, CO.

proximately 600,000 networking students in private and grassroots initiatives (Itzkan, 1992). Networking growth, however, unlike PCs, has been exponential. Usenet and Internet have seen growth rates of 50 to 100 percent annually. This is unprecedented. It is unlikely that networking at the K-12 level will grow as dramatically, but sustained levels of 20 to 30 percent do seem probable. The increasing movement for school, district, and statewide networks will fuel this growth. We may expect between approximately 3 and 5 million networking K-12 students in the U.S. by the end of the decade (Figure 2). At the upper end, that is more than 10% of the total U.S. public school student population.

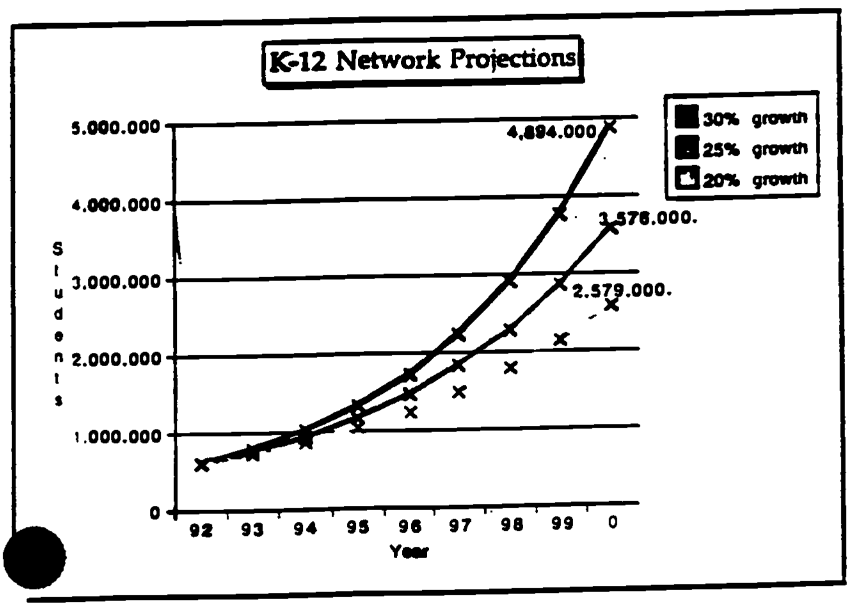

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Figure 2. Growth Projections for K-12 Networking

Diffusion Theory

With the previous techniques conclusive of the types of technologies and rates of growth, it now becomes essential to understand the processes of their diffusion. This is perhaps the most important part of a technological forecast—the qualitative, not the quantitative, element. To suppose that new technologies will continue to fit old models is a mistake. They do not.

Three Phases of Change

Typically, the impact of a new technology will pass through three phases. These are (1) a substitution phase, (2) a transition phase, and (3) a transformation phase (Figure 3). In the substitution phase, the technology replicates or automates existing practice. It does what people already know how to do, but better. It does not challenge existing paradigms. In the transition phase, new methodologies begin to evolve. The technology is now doing things that it wasn't necessarily brought in to do and is challenging old models. In the transformation phase, the technology has created completely new methodologies and proven the old ones obsolete. The task for which it was originally acquired, may no longer even be desired.

Perhaps nowhere is an illustration of this model more revealing than in regards to telecomputing itself. The evolution of computers, networking, and international networking or "global classroom activities" is strikingly demonstrative of the process. In each case, a technology is brought in to automate a previously existing practice, and inevitably begins to redefine the whole context of the operation. Figure 4 shows this in greater detail. The trends are shown passing through the three phases of social adoption.

Electronic Paper to Cognitive Agent

The transformation in the utilization of computers is most indicative. When computers were first introduced to schools, they acted essentially as electronic paper, replicating the drill and practice that was already familiar. Eventually new methodologies emerged, bringing with them instructional learning systems, *HyperCard* exploratory programs, and heated debates over implementation philosophy. This is the transition phase of instructional computing, and it describes, to a large extent, the current situation in many schools. Tomorrow's computers, however, will take us quite farther. Implementations of artificial intelligence and methodology taken from cognitive science (such as semantic networks) will allow computers to work on behalf of their user. They will recognize their speech, know what they are interested in, and facilitate exploratory learning through a world of contextually rich resources. Instructional methodologies will have to support variable time frame and individualized learning.

1. Substitution

Automates previous function

↓

2. Transition

Functions begin to change

↓

3. Transformation

Entirely new functions

Figure 3.
Phases of Technological Diffusion

Colorful descriptors of such instructional tools are "cognitive agents" and "knowledge navigators." Gone will be the days of standard curricular models and drill and practice. The computer will have made obsolete the very methods it was first used to reinforce.

Automated Messaging to Instructional Landscape

The network is another prime example. When first installed, networks were forms of automated messaging. For many, this was exactly their justification—to speed the delivery of administrative forms. Today, that would be considered a primitive utilization. Networks are now a form of resource sharing. The linking of schools with libraries, colleges, and other institutions provides a value-added service to all players in the shared communications medium. In the future, networks may come to define the instructional landscape itself. The resources of a school, library, or even district may be measured by its "access to the network"—what services it is connected to and how many students can utilize them. We must consider the prospect that school districts themselves are on the road to extinction. Districts are based on geographic boundaries that are of increasingly diminished significance. Networks can readily create "virtual districts" with students, teachers, resources, and even administrators distributed around the world. In fact, many of the grassroots educational networks, such as KIDLINK, FrEdMail, and Academy I may already be considered autonomous *virtual districts*. The network which was brought in to automate communications within a district may, in fact, supersede it.

Networking growth has been exponential. Usenet and Internet have seen growth rates of 50 to 100 percent annually. This is unprecedented.

	PCs	Networking	Global Classroom
Substitution (new technology)	• Computers as electronic paper	• Networks as automated messaging	• Students as "pen pals"
Transition (new methodology)	• Priestly vs prophetic paradigm	• Resource sharing	• International collaboration
Transformation (new paradigm)	• Computers as cognitive agents	• Networks as educational landscape	• Students as "global citizens"

Figure 4
Phases of Technological Diffusion for Three Trends

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The computer will have made obsolete the very methods it was first used to reinforce.

Pen Pals to Global Citizens

The last trend, that of international networking, or what is called *global classroom activities*, once again indicates the model of technological diffusion. At first international networking was predominantly used to create electronic "pen pals." Students wrote each other notes just as they would in any pen pal initiative. The international and speedy delivery made it exciting, but there were no methodologies to adequately exploit the technology. Today, global networking is clearly a means of academic collaboration. Students now work on international projects from all disciplines, such as science, foreign language, social studies, and global awareness. These programs, as innovative as they are, are still just stepping stones. International collaborative programs have become "real world" oriented, with students doing hands-on projects that draw from or make contributions to their schools and communities. Ultimately we may come to see that students are global citizens in a world society, and that international networking initiatives are not just school projects, but vehicles for the exercise of citizenship.

Considerations for Education

With the forecast tools now employed, the school administrator should have a better picture of what is coming. The opinions of the experts appear to be justified. An era of comprehensive instructional networking is on its way. The last step is to assess what this means for schools, districts, and classrooms.

Benefits for Instruction:

For education in general, the effects can be quite beneficial. Appropriate use of the new capabilities can turn classrooms into living laboratories, fully connected and interactive with people and resources around the world. The following is a brief description of how curricular areas may be influenced.

- Language—foreign language classes will use voice and written E-mail to communicate with peers who are native speakers. Instead of listening to tapes and filling out worksheets, students will use the computer networks to listen and write to each other.
- Science—science classes will be augmented by interaction with experts who are doing research. Students will witness and communicate with those who are taking part in explorations, high energy physics, space walks, and so forth.
- Biology—biology classes will be linked to local hospitals and clinics. Students may witness operations or perform their own tests and experiments using advanced research facilities.
- Social Studies—social studies classes will use global networking as a form of group study on issues such as cultural awareness, politics, history, and current affairs. The global network will become an international student forum in which an endless variety of projects will take shape.

Administrative Considerations

On the administrative side, the growth of a network-based instructional environment raises a host of questions and issues, many of which may be quite troublesome. Although instructional opportunities will be advanced, administrative activities will be altered and redefined. We lack the space here to explore the issues in depth, but a brief list of some of the pressing questions raised is as follows:

1. What will happen to school libraries?
2. Will schools still need to require attendance?
3. Will smaller school districts be cut off from information highways?
4. Will computer networks make school districts obsolete?
5. Will schools and districts need to establish collaborative relationships with "information providers"?
6. Will companies like AT&T compete with schools and libraries?
7. Will the superintendents need to be a network administrators?

These questions and others like them, show the magnitude of what today's educational administrator must begin to consider. Though their answers lie in the future, it is already clear that to approach them, schools must begin to operate in an open and flexible networked environment. Information and resources will be abundant, accessible, and constantly updated. Curricular projects will be changing by the day, and it is quite possible that no two classes will ever do exactly the same experiment or use exactly the same material twice. Schools themselves must ultimately become learning institutions. ■

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References

Abrams, J. (1993, Sept.). *Preliminary Report Revised* (unpublished).

Itzkan, S. (1992, October). How big is the global classroom? *Matrix News*, *2*(10), 1, 7-8.

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This document is a draft of one of several reports prepared for The Road Ahead (1995-1997), a program of the National Foundation for the Improvement of Education (NFIE), a nonprofit foundation of the National Education Association (NEA). The Road Ahead was funded by Bill Gates, co-founder and CEO of Microsoft Corporation, from proceeds from his book by the same name. The program involved 22 school/community partnerships in 15 states using technology-based learning activities that extend beyond the traditional classroom and school day.

This draft is subject to review and revision, and was prepared by staff of the International Society for Technology in Education (ISTE). ***All statements and opinions expressed are those of the authors and do not represent policies or positions of the NEA, NFIE, ISTE, or Microsoft Corporation.***

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Foundations for The Road Ahead: An Overview of Information Technologies in Education

Information technologies such as computers, telecommunications, and digital cameras are changing the way we work, play, and learn, as well as what we learn. This paper provides an introduction to some of the instructional uses of the information technologies in K-12 education. It includes:

- Scenarios of current uses.
- An overview of information technology uses in the classroom.
- Goals for using information technologies in education.
- An annotated bibliography.

Links to major headings

- Scenarios
- The Information and Communications Age
- Overview of Instructional Information Technolgies
- Goals for Information Technology in Education

- The Challenge
- Bibliography

Scenarios

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Information technologies are becoming more common in our formal and informal educational systems. The scenarios below illustrate the breadth of current uses in our schools. Each scenario also raises issues for how these uses of technology can be sustained, improved, and integrated into education. Some of these issues, including professional development, assessment, school-community partnerships, and implementing project-based learning, are addressed in companion reports in this series.

• Teams of fourth-grade students develop World Wide Web pages as part of their study of countries around the world. The main focus is on what life is like for children growing up in other countries. Each team uses information from the school's CD-ROMs, the Internet, and the print resources available in the school library. This assignment helps develop each student's ability to retrieve and integrate information from multiple sources. The task also gives students practice working together as a team and learning from each other. The students are especially motivated because they know that their Web pages will become part of their portfolios and will be used by other students-perhaps even some from other countries.

Issues : The quality of information available from different Web sites varies tremendously. Can fourth grade students learn to differentiate between high-quality and low-quality information? Can they learn to deal with huge numbers of sources of information-sources that may well provide contradictory information? How does a teacher assess the work of students who are working in teams, with each team is working on a different project? How do students and teachers learn to develop and work with electronic portfolio materials?

• Students in an ninth-grade microcomputer-based laboratory (MBL) have set up experimental equipment to track a moving object. The tracking device, which is similar to an automatic range finder in a camera, feeds data into a computer. The computer analyzes the data and produces graphs of distance, speed, and velocity. One of the activities has students track their own movements and attempt to move their bodies to produce certain types of graphs.

Issues: The computations and analysis being done by the computer system is beyond the level of mathematics that the student has studied. This is merely one of many possible examples in which computer facilities make it possible for students to carry out experiments and analysis at a much more advanced academic level than would be possible if they were drawing only on their (traditional) academic background. This raises issues such as staff development, student assessment, and articulation with courses that feed into and/or follow from a microcomputer-based laboratory course.

• A student communicates using a voice synthesizer with which she can pick letters and words by using the small amount of movement that she has in one hand. She uses this same equipment to write, look up information on CD-ROMs, and communicate with friends throughout the world using e-mail.

Issues: Adaptive technologies can help many physically challenged students function successfully in regular classrooms. However, this technology is often new to the teacher and to the school's technology support system. The teacher and other students may need assistance learning to work with adaptive technologies and the students using them.

• A sixth-grade class project focuses on how to preserve and enhance the wetlands. Their school has a partnership with a local surveying company. The company is providing both personnel and equipment to assist students during their field trip to a wetlands area. The students are taking video and still-camera pictures; they are recording field notes using tape recorders and laptop computers. They are developing a video and a hypermedia stack on ways to preserve the wetlands. They intend to use these materials in presentations to parents and the City Council.

Issues: Learning to make effective use of such a range of equipment is a challenge both to students and to their teachers. Some schools and school districts may also be challenged by the idea of students and their teachers being engaged in studying and reporting on politically sensitive "real world" topics.

• Teams of students in a third-grade class are building computer-controlled model houses and cars. A model house contains lights and a garage door opener that can be controlled using a computer program that the students are writing. A model car is powered by electric motors and contains sensing devices that tell when the car has run into a wall. The students are writing a computer program that will guide the car through a maze.

Issues: Questions that might be asked concerning this educational environment include: How does this learning environment affect students progress in learning the "basics"? Is this a cost-effective approach to curriculum improvement? Is the teacher receiving adequate support for professional development, curriculum development, and learning to assess student work in this environment?

• Students in a 10th-grade social studies class are studying complex systems such as a city, farm, or rain forest economy. They are making use of computer simulations in which they can "build" objects such as roads, building, parks, airports, and power plants. Goals in these various computer simulations include developing a functional economy, managing growth and change, and making effective use of resources. The computer simulations are interactive and require students to deal with changing economic situations and unforeseen natural disasters. The students solve problems individually and collaboratively, consult each other for opinions and advice, and share their successes and failures.

Issues: What are students actually learning, and how can this learning be assessed? Are the simulations technically and educationally sound? Do the teachers have the knowledge and skills to integrate use of simulations into the curriculum?

• Each of the students in a high school calculus class has a hand-held calculator/computer on loan from the school. Although the device has the look and feel of a pocket calculator, it has many of the characteristics of a complete microcomputer. The calculator is specifically designed for use in math and science settings. It can graph functions, solve equations, and carry out a wide range of tasks that students typically learn to do "by hand" in a calculus course. The course content and assessment are presented to students in a manner that assumes routine access to the calculator/computer.

Issues: How is the use of calculators aligned with students' previous math courses, and with other courses in math and science that the students take now and in the future? What happens if a calculator is lost, stolen, or broken? Has the teacher had appropriate

opportunities to learn about instruction and assessment in classes where calculator use is assumed and required?

• All teachers in a secondary school make use of electronic gradebooks. Student records are posted using pseudonyms to ensure confidentiality. Students can monitor their progress, check for missing assignments, and determine how well they are doing relative to the rest of the class. End-of-term reports are quickly produced and sent electronically to the central office. The same electronic gradebook system helps teachers provide individualized written reports to students and their parents at any point throughout the term.

Issues: Do the teachers have access to the needed hardware and software both at school and at home? Who pays for this hardware and software? Is adequate staff development and technical support available?

These scenarios are representative of the changing roles of teachers and students that are made possible by the information technologies. The changes illustrated in these scenarios have already occurred or begun in some schools. They are all part of the increasing use of information technologies in our educational system.

All of the issues center around change and how to facilitate change. Every school is being challenged by issues of professional development, curriculum development, alternative assessment, technical support for students and teachers, and articulation of efforts with the larger school and district programs. Every school is being challenged by the costs of computer hardware and software, as well as by how rapidly such facilities become antiquated.

The Information and Communications Age

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We are now just at the beginnings of an Information and Communications Age. The term cyberspace is used to describe the world of computer networks, the Internet, and the World Wide Web. Information highways are linking the world. Multimedia-text, sound, graphics, and video-are combined in documents that are distributed on computer networks. Information retrieval and problem-solving systems are interactive. Artificial intelligence agents and expert systems are increasingly being used to help solve complex problems.

Cyberspace is changing quite rapidly. On a worldwide basis, the total amount of computer-based information-processing power is doubling approximately every two to three years. Fiber optics and wireless networks are being installed throughout the world. People now talk about the "length" of a cyberspace year as being perhaps two or three months. In other words, the pace of change in cyberspace is several times as fast as the pace of change in other parts of our world, such as business, government, and education.

Many people find it helpful to recognize three major changes in human history that have helped to shape education:

1. **The development of reading and writing.** Rudiments of this date back nearly 10,000 years. Reading and writing are powerful aids to the accumulation, use, and dissemination of knowledge. They are core components of every good educational system.
2. **The development of movable type.** The work of Gutenberg and others about 550 years ago facilitated the printing of multiple copies of books. More copies of accumulated information could be made, and these could be more widely disseminated. This led to a considerable

increase in literacy rates and major changes in the societies of our world.

3. **The merger of print, telecommunications, and computers**. This is occurring right now, and has two main characteristics. First, technology greatly speeds up the storage, movement, and retrieval of information. People can remotely access the libraries of the world. Second, the computer can help process information and solve problems.

The merger of print, telecommunications, and the computer has advanced to the point that elementary school students are now developing interactive multimedia documents and World Wide Web pages that are being used to communicate with people throughout the world. Both students and teachers are learning how to use computer tools as routine aids to problem solving and personal productivity.

Overview of Instructional Information Technologies

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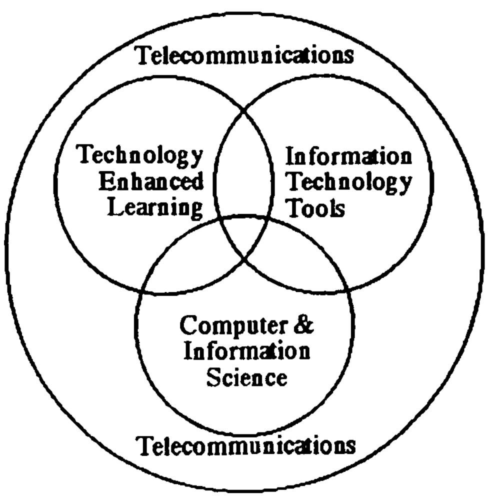
This section presents an overview of instructional information technologies that are becoming increasingly commonplace in our schools. The diagram below shows three main overlapping categories of instructional information technologies, with telecommunications tying them all together.

Computer Networking

The telecommunications industry was born in 1844, with the construction of the first commercial telegraph system connecting Baltimore to Washington DC. It received a big boost with the development of the telephone in 1876. There has been continual growth ever since. Recent years have seen the development of communication satellites, fiber optics, cellular telephones, and digital information systems.



Global computer networks are growing rapidly in capacity and use.

The Internet is an increasingly important part of the global, digital telecommunications system. Use of the Internet is growing rapidly, as are its capabilities. Large collections of reference materials and databases are being digitized and brought online. Through the use of the World Wide Web and the Internet, people can send and receive documents that include text, sound, graphics, and video. The increasingly interactive and graphical capabilities of the World Wide Web are making possible "virtual" museums, virtual field trips, and other exciting learning opportunities for students throughout the world.

The totality of information accessible through the Internet can be thought of as a global library. The emerging global library already dwarfs by many hundred-fold the libraries available in a typical precollege school. Increasingly, students and teachers have easy access to library materials that used to be available only to scholars living near the great research libraries of the world.

Computer and Information Science

During the past 50 years, computer and information science has emerged as a major discipline of study. In addition to computer programming, major components of computer and information science include databases, networking, human-machine interface, and artificial intelligence (AI). AI

addresses such problems as voice input to computer, language translation by computer, and expert systems that can solve complex problems.

Many ideas from computer and information science are now taught at the K-12 level. Some schools specify elective courses, such as programming languages, advanced placement computer science courses, robotics, and electronics. Other schools integrate instruction about computers into noncomputer curricula. For example, some computer programming might be integrated into mathematics courses, while some electronics might be integrated into middle school science.

Information Technology Tools

The computer is a useful and versatile tool. It can be used to help solve the problems and accomplish the tasks that are at the center of many different academic disciplines. Computer tools for education can be divided into three categories:

Generic tools: These are interdisciplinary tools such as word processors, spreadsheets, database managers, and graphics packages. All of the tools in an integrated package such as ClarisWorks or Microsoft Works are examples of generic tools. A student who learns to use these tools can apply them in almost every area of intellectual work.

Subject-specific tools: These are tools that are designed for use in a particular academic discipline. Examples include the Musical Instrument Digital Interface (MIDI), hardware and software to aid the composition and performance of music, and Computer-Assisted Design/Manufacturing (CAD/CAM).

Learner-centered tools: These are tools that require the user to develop some programming skills, but that focus on learning to learn and on learning specific subjects such as math, music, or science. Most hypermedia authoring systems and all Logo programming environments serve as examples.

Appropriate use of such technology in the curriculum requires a substantial amount of staff professional development, curriculum modification, and support from school administrators and parents. It also requires that educators develop answers to questions such as:

- What should students learn to do mentally?
- What should students learn to do assisted by simple aids such as books, pencils, and paper?
- What should students learn to do assisted by more sophisticated aids such as calculators, computers, and the Internet?

The computer is also a teacher productivity tool. Using a computerized gradebooks, assembling data banks of exam questions, preparing individualized education plans (IEPs) for students, and word processing lesson plans and class handouts are ways teachers can benefit from computer technology. These uses increase the teachers' productivity by improving overall efficiency of effort and saving valuable time. Further increases in productivity occur when networks allow teachers to easily share successful materials.

Both teachers and students are making increasing use of desktop presentation stations. Material that is stored in a computer is projected onto a screen for whole-class or small-group viewing. The system also allows sharing of materials that are generated during class interaction. For example, in a science class, a projection system can display analyses of data generated in experiments conducted by students or teachers.

Technology-Enhanced Learning (TEL)

There are a number of ways in which information technologies can be direct aids to learners. The combination of such aids is called Technology-Enhanced Learning (TEL). TEL includes:

1. Computer-assisted learning (CAL). CAL includes drill and practice, tutorials, simulations, and virtual realities. Most CAL systems also include record keeping and management systems. CAL can be used as a supplement to traditional instruction, but it can also be used to present entire units or courses of study. Note that CAL also goes by a variety of other names such as computer-assisted instruction and computer-based instruction. A huge amount of CAL materials have been developed, and are widely available in schools. Many schools find such materials to be highly motivating to students and an effective aid to learning.
2. Distance education. There is a steadily increasing number of complete courses and major units of study that are "delivered" electronically from outside the school. Delivery systems include television or video tape, two-way audio and one-way video, two-way audio and two-way video, the Internet, and the World Wide Web. Distance education is increasing the learning opportunities available to students.
3. Electronic access to information. This includes access to information stored on CD-ROMs as well as access to information on the Internet. Increasingly, students and teachers are making use of current information retrieved through use of the Internet, rather than relying on printed books that may be a number of years old.
4. Electronic aids to student and teacher interactivity. Examples of the technology being used include desktop presentation systems, e-mail, and groupware. Groupware is a type of software designed to facilitate a group of people who are connected through a computer network to work together on a task; the participants may be located thousands of miles apart.
5. Productivity tools with built-in "help" features. Modern productivity software such as word processors, spreadsheets, or graphics packages include built-in learning aids, context sensitive help, templates, and other aids to producing high-quality products. These help users learn while doing.

As the use of TEL increases, more and more education will take place at a time and place that is convenient to the needs of the learner. This convenient education and is an increasing component of both formal and informal education. Convenient education helps learners to take increasing responsibility for their own learning.

Just-in-time education is a second important aspect of TEL. Many learning tasks can be completed in a few minutes, a few hours, or a few days-just in time to apply the skills when needed. How rapidly and effectively the learning occurs depends on the background and capabilities of the learner and on the learning environment. One of the driving forces for school restructuring is the goal of helping students gain increased skill in being just-in-time learners. This is an important component of learning to learn and being a lifetime learner.

A third aspect of TEL can be found in the changing capabilities of the informal educational system. Almost all home computers come equipped with a CD-ROM drive. There is steadily increasing access to the Internet and the World Wide Web from home, library, community, and business locations. Just-in-time and convenient education are becoming available to more and more people. As the amount and quality of convenient education materials continues to increase, there is the potential that more and more of the traditional content of formal education will be learned in informal educational settings. The role of formal education-and of the teacher-will change.

We can get a glimpse into potential changes by asking ourselves what the unique characteristics are of a human, face-to-face, "live" teacher, as contrasted with TEL. Although there are many answers, several of the most important ones are:

1. The human-human interface. This aspect of the human teacher is far better than any current human-machine interface. Teachers can read the

body language and moods of students and the class. Teachers can know their students and interact with them in a manner appropriate to the needs of human beings.

2. The versatility of the human teacher. A human teacher can facilitate an interdisciplinary discussion that ranges over whatever comes to the minds of the students and the teacher. The human teacher has flexibility and capabilities that far exceed those of any current computer system in this regard.
3. The teacher as a facilitator of the social development of students. Teachers play a major role in helping students gain and improve social skills.

In the future, our formal educational system will concentrate more of its structured efforts on making effective use of the uniquely human characteristics and strengths of human teachers. More of the subject matter content and rote-skill components of the curriculum will be left to TEL. It is clear that the roles of teachers will change. The types of changes that are occurring are often described as having the teacher be a "guide on the side" rather than a "sage on the stage."

Goals for Information Technology in Education

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Essentially all students in the United States have access to computers and other information technologies. A 1995 U.S. Office of Technology Assessment report indicated that the public schools in the United States had an average of about one microcomputer per nine students.

Moreover, about 40% of the households in the United States now have a general-purpose microcomputer. Many of the households that have microcomputers indicate that "education" is one of the main reasons a microcomputer was acquired.

This section lists 12 goals for computer technology in education. These goals have emerged and evolved during the past 15 years as microcomputers have come into common use in schools and as the information highway has developed. These goals are divided into three major categories: Functional Technology Literacy; Independent Lifelong Learning; and Capacity Building. A more detailed discussion on the ideas of this section is given in Effective Practice: Computer Technology in Education (Moursund, Bielefeldt, Ricketts, & Underwood, 1995).

Student Goals: Functional Technology Literacy

The four goals listed in this section serve to define functional technology literacy and provide guidelines to K-12 curriculum developers. Notice the combined emphasis on both basic skills and on higher order, problem-solving skills.

Goal 1: Computer literacy, basic level. All students shall be functionally computer literate. A basic level of computer literacy should be achieved by the end of the eighth grade. It consists of a broad-based, interdisciplinary, general knowledge of applications, their capabilities and limitations, and how they work, as well as the societal implications of computers and other information technologies. Here are six specific objectives that underlie this goal.

A. General knowledge. Students shall have oral and reading knowledge of computers and other information technologies and their

effects on our society. More specifically, every discipline that students study shall include instruction about how electronic aids to information processing and problem solving are affecting that specific discipline.

B. Procedural thinking. Students shall have knowledge of the concept of effective procedure, representation of procedures, roles of procedures in problem solving, and a broad range of examples of the types of procedures that computers can execute.

C. Generic tools. Students shall have basic skills in the use of word processing, database, computer graphics, spreadsheet, and other general purpose, multidisciplinary application packages. This also includes basic skills using menu-driven hypermedia software to create hypermedia materials as an aid to communicating.

D. Telecommunications. Students shall have basic skills using telecommunications to communicate with people and to make effective use of computerized databases and other sources of information located both locally (e.g., in a school library, a school district library, or a local community library) and throughout the world. They shall have the knowledge and skills to make effective use of the Internet and the World Wide Web.

E. Hardware. Students shall have basic knowledge of the electronic and other hardware components and how they function sufficient to "dispel the magic." They shall understand the functionality of hardware sufficient to detect and correct common difficulties, such as various components not being plugged in or not receiving power, various components not being connected, and printer out of paper.

F. Computer input. Students shall have basic skills in the use of a variety of computer input devices, including keyboard, mouse, scanner, digital camera, and probes used to input scientific data. They shall have introductory knowledge of voice input, touch screens, and pen-based systems.

Goal 2: Computer literacy, intermediate level. Deeper knowledge of computers and other information technologies as they relate to the specific disciplines and topics one studies in senior high school. Here are some examples:

A. Creating hypermedia documents. This includes the ability to design effective communications in both print and electronic media, as well as experience in desktop publication and desktop presentation.

B. Using computers as aids to problem solving in the various high school disciplines. A student taking advanced math would use computer modeling. A commercial art student would create and manipulate graphics electronically. Industrial arts classes would work with computer-aided design. Science courses would employ microcomputer-based laboratories and computer simulations.

C. Computer-mediated, collaborative, interdisciplinary problem solving. This includes students gaining the types of communication skills (brainstorming, active listening, consensus-building, etc.) needed for working in a problem-solving environment.

Goal 3: Computer-as-tool in curriculum content. The use of computer applications as general-purpose aids to problem solving using word processors, databases, graphics, spreadsheets, and other general purpose application packages shall be integrated throughout the curriculum content. The intent here is that students shall receive specific instruction in each of these tools, probably before completing elementary school. Middle school, junior high school, and high school curriculums shall assume a working knowledge of these tools and shall include specific additional instruction in

their use. Throughout secondary school and in all higher education, students shall be expected to make regular use of these tools, and teachers shall structure their curriculum and assignments to take advantage of and add to student knowledge of the computer as a tool.

Goal 4: Information technology courses. A high school shall provide both of the following "more advanced" tracks of computer-related coursework. A. Computer-related coursework preparing a student who will seek employment immediately upon leaving school. For example, a high school business curriculum should prepare students for entry-level employment in a computerized business office.

A graphic arts curriculum should prepare students to be productive in the use of a wide range of computer-based graphic arts facilities. Increasingly, some of these courses are part of the Tech Prep (Technical Preparation) program of study in a school.

B. Computer science coursework, including problem solving in a computer programming environment, designed to give students a college-preparation type of solid introduction to the discipline of computer science.

Student Goals: Independent Lifelong Learning

The three goals listed in this section focus on computer technology as an aid to general learning.

Goal 5: Distance education. Telecommunications and other electronic aids are the foundation for an increasingly sophisticated distance education system. Educators should use distance education when it is pedagogically and economically sound to increase student learning and opportunities for student learning.

Note that in many cases distance education may be combined with computer-assisted learning (CAL, see Goal 6), so that there is not a clear dividing line between these two approaches to education. In both cases students are given an increased range of learning opportunities. The education may take place at a time and place that is convenient for the student, rather than being dictated by the traditional course schedule of a school. The choice and level of topics may be more under student control than in our traditional educational system.

Goal 6: Computer-assisted learning (CAL). Education shall use computer-assisted learning when it is pedagogically and economically sound, to increase student learning and to broaden the range of learning opportunities. CAL includes drill and practice, tutorials, and simulations. It also includes computer-managed instruction (see Objective C). These CAL systems may make use of virtual reality technology.

A. All students shall learn both general ideas of how computers can be used as an aid to learning and specific ideas on how CAL can be useful to them. They shall become experienced users of CAL systems. The intent is to focus on learning to learn, being responsible for one's own learning, and being a lifelong learner. Students have their own learning styles; therefore, different types of CAL will fit different students to greater or lesser degrees.

B. In situations in which CAL is a cost-effective and educationally sound aid to student learning or to overall learning opportunities, it will be an integral component of the educational system. For example, CAL can help some students learn certain types of material significantly faster than can conventional instructional techniques. Such students should have the opportunity to use CAL as an aid to learning. In addition, CAL can be used to provide educational opportunities that might not otherwise be available. A school can expand its curriculum by delivering some courses largely using CAL.

C. Computer-managed instruction (CMI) includes record keeping, diagnostic testing, and prescriptive guides of what to study and in what order. CMI is useful to both students and teachers. Students should have the opportunity to track their own progress in school and to see the rationale for the work they are doing. CMI can reduce busywork. When CMI is cost effective and instructionally sound, staff and students should have this aid.

Goal 7: Students with special needs. Computer-related technology shall be routinely and readily available to students with special needs when research and practice have demonstrated its effectiveness.

A. Computer-based adaptive technologies shall be made available to students who need such technology for communication with other people or for communication with a computer.

B. When CAL with demonstrated effectiveness is available to help students with particular special learning needs, it shall be made available to the students.

C. All staff who work with students with special needs shall have the knowledge and experience needed to work with these students who are making use of computer-based adaptive technologies, CAL, and computer tools.

Educational System Goals: Capacity Building

The five goals in this section focus on permanent changes in our educational system that are needed to support the achievement of Goals 1-7.

Goal 8: Assessment. Student assessment shall reflect the student goals listed above. For example, when students are taught to write and solve problems using the computer as a routine tool, they shall be assessed in that same environment.

Goal 9: Staff development and support. The professional education staff shall have computers to increase their productivity, to make it easier for them to accomplish their duties, and to support their computer-oriented growth. Every school district shall provide for staff development to accomplish Goals 1-8, including time for practice, planning, and peer collaboration. Teacher training institutions shall adequately prepare their teacher education graduates so they can function effectively in a school environment that has Goals 1-8.

This means, for example, that all teachers shall be provided with access to computerized data banks, word processors, presentation graphics software, computerized gradebooks, telecommunications packages, and other application software that teachers have found useful in increasing their productivity and job satisfaction. Computer-based communication is becoming an avenue for teachers to share professional information. Every teacher should have telecommunications and desktop presentation facilities in the classroom. Computer-managed instruction (CMI) can help the teacher by providing diagnostic testing and prescription, access to item data banks, and aids to preparing individual education plans.

Goal 10: Facilities. The school district shall integrate into its ongoing budget adequate resources to provide the hardware, software, curriculum development, curriculum materials, staff development, personnel, and time needed to accomplish the goals listed above.

Goal 11: Long-term commitment. The school district shall institutionalize computers in schools through the establishment of appropriate policies, procedures, and practices. Instructional computing shall be integrated into job descriptions, ongoing budgets, planning, staff development, work assignments, and so on. Every school shall have a goal of increasing the functional computer literacy of its students and shall have appropriate

methods for adequately assessing students' computer literacy. The district shall fully accept that "computers are here to stay" as an integral part of an Information Age school system.

Goal 12: Community-wide commitment. The community-the entire formal and informal educational system-shall support and work to achieve the goals listed in this section.

The Challenge

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The 12 goals listed in the previous section are all designed to support the overall goals of education. They bring some new dimensions and new senses of direction to education. They are a change in an of themselves, and they facilitate change throughout the school curriculum.

However, the underlying goals of education remain unchanged. Our educational system needs to help every student meet high standards of academic achievement. It needs to help prepare students for the adult responsibilities that they will face. Finally, our educational system needs to prepare students for life in a rapidly changing Information and Communications Age.

To do this will require a concerted effort by both our formal and informal educational systems. Although adequate access to computer hardware and software remains a major issue, there are other critical problems. These include staff development, education designed to help parents and other community members learn about computer technology in education, curriculum development, and changes to our assessment system. Many of the schools experiencing success in such changes are involved in restructuring efforts that go far beyond computer technology.

Bibliography

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Apple Computer, Inc. (1995). *Apple education research reports*. Eugene, OR: ISTE.
This is a reprint of the Apple Classroom of Tomorrow research studies, as well as other reports that are based on analysis of the research literature. It is a good source of information about what happens when students have a great deal of access to computer technology, such as computers at home and at school for each student.

Austin, T., et al. (1993). *The technology advisory council: A vehicle for improving our schools*. Eugene, OR: ISTE.
This book contains detailed information about how to establish a Technology Advisory Council (TAC) in a school or district. It identifies key stakeholder groups and discusses some of the needs of these groups. It outlines the types of activities that a TAC can do to help provide technology leadership in a school or school district. The book includes an annotated bibliography and a glossary of key terms.

Bangert-Drowns, R. (1993). *The word processor as an instructional tool: a meta-analysis of word processing in writing instruction*. Review of Educational Research, 63(1), 69-93.
There has been a great deal of research on the effects word processing has on students' learning to write. Computers are a significant aid to students mastering the concept and practice of writing as a process-that is, process writing.

Becker, H. J. (1994). *How our best computer-using teachers differ from other teachers: Implications for realizing the potential of computers in schools*. Journal of Research on Computing in Education, 26(3), 291-321.

Becker provides a list and analysis of characteristics of teachers who have been very successful in making instructional use of computers in their classrooms.

Braun, L., & Bielefeldt, T. (1995). *Celebrating success*. Eugene, OR: ISTE.

A number of school sites with successful instructional applications of computer technology are cataloged, along with contact information.

Brody, P. J. (1995). *Technology planning and management handbook: A guide for school district educational technology leaders*. Englewood Cliffs, NJ: Educational Technology Publications.

Brody provides a functional approach to the wide range of activities that a school district faces because of technology in education. This book is suitable for people who are just starting to deal with the challenge of integrating technology into the curriculum. It also provides a good summary and overview for schools and districts that are more deeply involved.

Educational Software Evaluation Consortium. (1997). *The 1997 educational software preview guide*. Eugene, OR: ISTE.

This guide is developed each year by the Educational Software Evaluation Consortium, a group of educational software preview centers. The book lists more than 800 pieces of K-12 classroom software that receive high evaluation ratings. It also includes addresses for the publishers of these pieces of software.

International Society for Technology in Education. (1993). *Curriculum guidelines for accreditation of educational computing and technology programs*. Eugene, OR: Author.

A detailed report on the National Council for Accreditation of Teacher Education (NCATE) standards for teacher preparation in educational technology. Current and developing guidelines are maintained on the World Wide Web at http://www.iste.org/standards/noframe.htm.

International Society for Technology in Education. (In press). *Foundations for The Road Ahead* (series). Washington, DC: National Foundation for the Improvement of Education.

This series of six short reports, prepared as background for The Road Ahead program of NFIE, summarizes the literature and current practices in educational technology. In addition to the present document, the series includes the following titles:

Assessment: Information technologies in the K-12 curriculum.
Computer technology and professional development: Suggestions for schools.
Obtaining resources for information technology in education: A guide for beginners.
Project-based learning and information technologies.
School-home-community connections: Roles of information technologies.

Kulik, J. A. (1994). *Meta-analytic studies of findings on computer-based instruction*. In E. L. Baker & H. F. O'Neil, Jr. (Eds.), Technology assessment in education and training. Hillsdale, NJ: Lawrence Erlbaum Associates.

Kulik is undoubtedly the world's leader in doing meta-analyses on computer-assisted instruction. This extensive article is a meta-analysis of meta-analyses on CAL. It contains an extensive bibliography and is an excellent starting point for anyone interested in studying the CAL research literature.

Means, B., & Olson, K. (1995). *Technology's role in education reform: Findings from a national study of innovating schools.* Menlo Park, CA: SRI International.

Report from a project funded by the U.S. Department of Education. It examines a large number of schools and gives detailed case studies of nine sites that have taken a constructivist approach to education, with considerable emphasis on project-based learning in computer-supported environments.

Moursund, D. G. (1996) *Getting resources for technology in education: A guide for beginners*. Eugene, OR: ISTE.

A how-to guide to writing proposals and to other methods for obtaining resources for technology in education. Although the main emphasis is on writing proposals, the book also contains chapters on developing partnerships with businesses, fundraising, entrepreneurship, and miscellaneous other ways of obtaining resources.

Moursund, D. G. (1996). *Increasing your expertise as a problem solver: Some roles of computers*. Eugene, OR: ISTE.

Moursund, D. G., Bielefeldt, T., Ricketts, R., & Underwood, S. (1995). *Effective practice: Computer technology in education*. Eugene, OR: ISTE.

Comprehensive summary and analysis of the research literature and other information on effective uses of computer technology in K-12 education.

Negroponte, N. (1995). *Being digital*. New York: Knopf.

A collection of short essays that explore the state of the art of computer technology from a multimedia point of view. Discusses how the ability to store, manipulate, and transmit "bits" of information (the hallmark of the Information and Communications Age) is changing the world.

Papert, S. (1993). *The children's machine: Rethinking school in the age of the computer*. New York: Basic Books.

Papert is well known for his work as a computer scientist at the Massachusetts Institute of Technology. He is still better known for his work as a computer educator, particularly in the Logo field. His philosophy of education is built on and extends the work of Piaget. The book focuses on hands-on, discovery-based learning by doing and taking advantage of Logo and similar powerful new learning environments.

Sarason, S. B. (1990). The predictable failure of educational reform. Can we change course before it's too late? San Francisco: Jossey-Bass.

A key component of this book is an analysis of who has the power in our educational system. Sarason argues that school reform movements in the past have failed because there was no change in who was empowered. Sarason argues that students and teachers must be empowered if education is to be improved.

United States Advisory Council on the National Information Infrastructure. (1996). *KickStart initiative: Connecting America's communities to the information superhighway*. St. Paul, MN: West Publishing Company.

A comprehensive introduction to the Information Superhighway and ways to help a community become connected to it. The report was developed by a large team of people representing business, government, and education.

U.S. Congress, Office of Technology Assessment. (1995). *Teachers & technology: Making the connection* (OTA-EHR-616). Washington, DC: U.S. Government Printing Office.

A landmark study of technology in U.S. schools from the point of view of educators. Provides good insight into the current status and

possible futures of technology in K-12 education.

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Prepared for the National Foundation for the Improvement of Education by the International Society for Technology in Education. Subject to review and modification. Principal author: Dr. David Moursund. Contact: Talbot Bielefeldt, Research Associate (tbielefe@oregon.uoregon.edu).

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The Leadership Role in Making the Technology Connection

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Imagine this: At the end of a busy school day, you remember that you have a report to present to the board of school trustees tomorrow. The problem is, you have not gathered the information yet and do not have the traditional types of resources available at hand to complete the report. No problem! Using your computer, you call the state department of education computer and download any relevant information for the report. Then you log on to the Internet, where you find additional information. You save this so that you can use it at home later that night to develop your report. At home, you use all of the information you have gathered to develop the presentation for the board tomorrow.

> **The important question for us as educational leaders is whether or not we want to be part of the solution.**

Maybe this is not how you presently develop presentations, but this is a model that we must prepare ourselves, staff, and students to use in order to be successful in the future.

Setting the Stage

Technology presents new opportunities to change how we function, and leaders need to model the use of technology to change and improve the environment in which educators function. As we plan for technology in our school districts, we must keep two issues in mind:

- Technology has the potential to change how we work, teach, and learn in our school districts; and
- This potential will only be realized if leaders assume the lead role in realizing this potential.

In April 1995, the Office of Technology Assessment (OTA) released an extensive survey to the U.S. Senate that addressed the issue of how technology should change and improve education. The report, *Teachers and Technology: Making the Connection*, had a central theme: "we will never effectively realize the potential of technology to change education unless we address the issue of involving our staff in the use of technology".[1] If we are going to effectively address this concern, then we must reconsider our leadership role in promoting and defining the use of technology by our staff.

Research consistently finds that leadership is a key to successful implementation of technology. For example, Mergendoller (1994) states: "The role of the principal is crucial in promoting school technology use. Similarly, for technology to become diffused across a district, leadership by central administration, especially the superintendent, is critical. These findings are supported by the organizational change research, which has consistently found that change efforts do not succeed without active administrative leadership, particularly by principals. Research has shown that leaders perform four important tasks: (a) obtaining resources, (b) buffering the project from outside interference, (c) encouraging staff, and (d) adapting standard operating procedures to the project."[2]

As educational leaders, we need to provide leadership in addressing the necessary issues to realize the potential of technology. Leadership issues can be narrowed to the following five topics: Creating a Vision, Monitoring Influence, Funding, Involving Staff, and Creating Standards.

Creating a Vision

Technology will never provide the changes in education that it should until we create a local vision of how technology should impact how we work, teach and learn. The key is to develop a vision for technology in our school buildings and districts that will take our individual vision of how technology should influence what we do and making it a shared vision with others.

The importance of creating this shared vision cannot be underestimated. If we do not have a mutual vision of where technology will take us, then it will be difficult to set priorities, to know where we are headed, and to know when we have achieved what we are trying to accomplish.

From Individual Vision to Shared

Through a partnership with our local telecommunications provider, Ameritech, we were able to expand our vision for the use of technology to include the following — productivity, communications, and learning.[3] In developing this shared vision of technology, Ameritech offered to review our district technology plan, as they do for many customers prior to purchases.[4] This is done to advise the customer whether present technology decisions will be compatible with future network solutions. Providing information about network solutions prior to hardware purchases eliminates much of the disappointment and frustration in finding that some products cannot function in a networked environments.

Our challenge is to constantly re-define how we use technology in order to take full advantage of its improvements. There are a number of factors to consider, but the first step is to develop a shared vision of the technology delivery system.

A Shared Vision

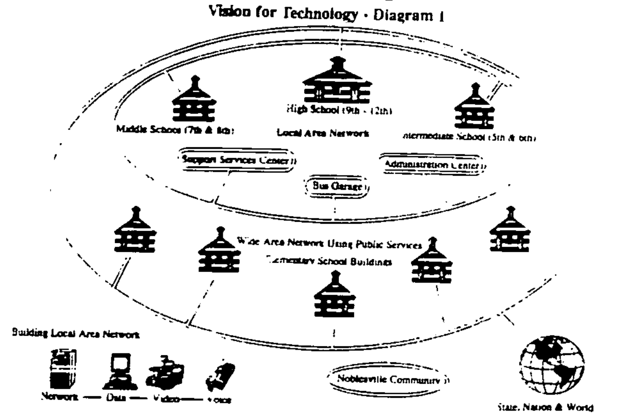
There needs to be a vision of how technology should be implemented to provide both connectivity and cost advantages so that present expenditures will support its use in a changing future. Too often, school personnel let a particular product or vendor determine what technologies to implement. Instead, we must

have a long-term vision of where we want to go.

Diagram 1 graphically shows the vision we at Noblesville Schools developed for technology. Once we decided to create a networked environment in our district, then other technology decisions to accomplish this purpose became easier. This makes it possible to balance short-term decisions with long-term purposes.

It is the responsibility of school leaders to guarantee that decisions and purchases will lead the school district to achieve the vision established for technology. Associated with this is the monitoring of influences that attempt to determine the use of technology within the school district.

Noblesville Schools
Vision for Technology · Diagram 1



Monitoring Influences

Many influences — both internal and external — affect how we use technology in our school districts. Too often, we have allowed individual vendors to decide for us how we use technology. It can be valuable to use vendors to help in planning and decision making, but it must always be remembered that they are more interested in selling their product than in providing direction for the future of your school district.

As leaders, we must also become users. And we must all be involved in planning and implementing technology in our school buildings. If we are preparing our students to work in a technology-rich environment, as educators we have an obligation to bring the best of technology into our schools. This will happen only if we become adept users of technology and apply it as a tool to make our schools better places to work and learn. We need to explore how technology will allow us to do more tasks effectively and implement those strategies. Furthermore, we have an obligation to share what we are doing with other educators so that they may also enjoy the advantages that technology provides.

Also, we need to look at what business has found about how technology can and should change the work place. Tapscott and Caston, in their book *Paradigm Shift*, explain how business first viewed technology as an opportunity to downsize and hopefully become more productive.[5] Most of the businesses that followed this model only have not been successful. This happened for two reasons:

1) It always takes more time to implement new technologies at the start and if this time is not provided, then the full benefits of the use of technology might not be realized; and,

2) Time saved from use of technology should be re-invested back into the business to make it more productive.

These two reasons must be foremost as we implement new technologies in the educational environment. The support, training and time must be provided so that new technologies can be effectively implemented, and once in place, we must reinvest the timesavings into other areas that will make what we do as educators more productive.

In addition, educators must also monitor the influences that impact funding for technology. Again, it will be difficult to influence decisions about funding if there is not a shared vision and support among the leadership for what the district [illegible] to accomplish.

Funding

We have to reconsider how we fund technology in our school districts. Too often we view technology as a single budget item and forget that there are two distinct aspects of funding technology. First, we need to budget for maintaining the technology we already have. This includes the replacement and repair of equipment, service agreements, and training of staff. It does schools more harm than good to implement new technologies at the expense of letting present programs and equipment go unused because staff are not trained or the equipment is not maintained.

Second, we must have funds available to implement new technologies and programs. This includes equipment, technical support and training. It is more important to make steady progress forward than to unrealistically assume that one day the funding will become available to do everything at once.

How you involve the community and how you use additional funds such as grants are two important aspects of providing leadership. Community involvement is critical to technology planning and implementation. The community connection is necessary to take advantage of resources available in the community and to gain community support, and should be viewed as an opportunity to develop partnerships, connectivity and deeper involvement.

Partnerships should be formed with the business community to obtain a better sense of how the world of work is changing. Visits should be made to businesses that serve your community and employ your graduates to develop a better understanding of the skills that business thinks students will need in the future. Also, try to develop joint ventures to train school and business staff in the use of new technologies.

Another funding source for schools is grants. Given the broad purpose of technology, it is not difficult to submit grant proposals that will assist a school district in achieving its technology purposes at a quicker rate than would be possible if only local resources were used. The important aspect, however, is that grant funding should not determine how we use technology in our schools. If the grant does not fit or cannot conform to your proposed uses of technology, then don't apply for that specific grant.

Involving Staff

As you plan and implement new technology, a number of things can be done to involve your staff. If staff are not included, then it is very unlikely that you will be able to maximize the use of technology. As school leader, we would suggest that you consider involving staff throughout the planning process, program coordination, curriculum development and staff training.

Planning Process

We have found that a number of areas must be addressed in order to develop an integrated technology plan. Those areas include defining responsibilities, coordinating programs, establishing standards, developing curriculum, and training staff. As you address these areas in your planning process, it is absolutely necessary that key staff members be included. This

should comprise both your teaching and support staffs. It is far more difficult to get support for a technology plan after the fact. Important aspects of the planning process include program coordination, curriculum development, and staff training.

Coordination

To have the necessary program coordination to carry out a comprehensive technology plan, a number of topics should be addressed. We suggest that you consider the following topics:

- Devising a building- and system-wide approach to planning and evaluation, which includes a defining of standards for the school district.
- Managing resources, figuring in the costs of installation, maintaining inventory, and ensuring that a support structure is in place.
- Offering a continuous and unified technology curriculum for everyone in the community, including kindergarten through adult levels.

Curriculum development is an ongoing process that will guide the selection and use of technology.

Curriculum Development

Major goals for technology must be developed for students and staff. Specific competencies for students should be created as part of a curriculum guide for each course and subject area taught within the district. Curriculum development is an ongoing process that will guide the selection and use of technology. Minimum competencies must also be established, and efforts made to guarantee that opportunities are being provided to all.

In addition to a curriculum guide, we suggest considering two specific areas for technology learning goals. First the *Technology-Specific Curriculum* (Chart 1) lists the minimum

TECHNOLOGY SPECIFIC CURRICULUM
Chart 1

The technology specific curriculum is listed according to skills and concepts associated with:

1) BASIC TECHNOLOGY USE
(Introduced by classroom teachers)

2) INFORMATION NAVIGATION
(Introduced by media specialists)

↔ Excellent opportunities for collaborative teaching

The following skills should not be taught in isolation, but as aids to teaching the existing school curriculum.

BASIC TECHNOLOGY USE	K	1	2	3	4	5	6	7	8	9	10	11	12
Introduction to keyboard	•												
Introduction to paint programs	•												
Alphabetic keys		•											
Formal keyboarding			•										
Introduction to word processing			•										
Keyboarding reinforcement				•									
Electronic mail				•									
Introduction to HyperCard				•									
HyperCard stacks (clip art, paint, scanned images)					•								
Numeric keypad					•								
Formal word processing					•								
Keyboarding speed and accuracy						•							
Create and organize a data base						•							
Introduction to graphic design						A							
Word processing - formatting and editing							•						
Introduction to object-oriented draw programs							A						
Word processing reports with title pages								•					
Extensive peripheral interactions								•					
Advanced paint programs									A				
Word processing with bibliography									•				
Create spreadsheets and graphs for problem solving									•				

* Indicates when a skill is introduced. It is expected to be used once introduced.

A Indicates concept or skill when it is introduced in Art classes.

INFORMATION NAVIGATION
Chart 2

The following concepts and skills can be taught by media specialists and are part of the library curriculum:

CONCEPTS AND SKILLS	K	1	2	3	4	5	6	7	8	9	10	11	12
DB - Alphabetizing, Classification	*												
Search - Sequencing, question formation	*												
Search - differentiation of subject, author, title	*												
Use OPAC		*											
Generate bibliography by author from OPAC		*											
Reinforce DB skills		*											
Reinforce Search skills		*											
DB - Subject, author, title searches in OPAC			*										
DB - Construct a DB in OPAC			*										
Search - Truncation			*										
Search - CD-ROM encyclopaedia			*										
DB - Generate bibliography of media from OPAC				*									
DB - Indexes and tables of contents				*									
Search - Wild card				*									
Introduction to bulletin board systems				*									
Acquaintance with various media - "visual literacy"				*									
Construct student search record					*								
DB - keyword searches in OPAC					*								
DB - community resource searches in OPAC					*								
Introduction to information file					*								
Telecommunications with NSPL, basic on-line search					*								
Dial-in to school OPAC from home					*								
Search - Boolean operators (and, or, not)					*								
Search - Correct form of proper names					*								
Search - function keys					*								
BBS - Compuserve weather information, Ideanet, Internet					*								
DB - Compile bibliographies of resources						*							
DB - citations vs. full text						*							
DB - comparison of sources - decision making						*							
BBS - Inter-library loan, SULAN						*							
Introduction to communications networks						*							
Search - Fields in citations, search strategies						*							
Search - Microfiche use										*			
On-line searching											*		
Multimedia production												*	

* Indicates when a skill is introduced. It is expected to be used once introduced.

Legend:

DB - Data Base
OPAC -Online Public Access Catalog
NSPL - Noblesville Southeastern Public Library
BBS - Bulletin Boards
SULAN- State University Library Automation Network

expectations for what our Noblesville students will accomplish at each grade level from kindergarten through twelfth grade. . expectations require teachers to integrate technology different subject areas according to a curriculum-integration focus list. This list helps us guarantee that all students, as they move through the grade levels, have acquired certain technology skills and have encountered technology in various subject areas.

Second, the *Information Navigation* (Chart 2) supplies a scope and sequence of learning goals related to information services available through the use of technology — research, online searching and automated library systems.

Training Staff

Staff development is a key to implementing and expanding the use of technology in any school district. Staff development needs should be determined by recommendations from:

- inservice committees in the elementary, middle and high schools;
- building technology committees; and
- district technology committee.

We cannot underestimate our leadership role in involving staff throughout our districts in the planning process, program coordination, curriculum development and staff training. Another key role is creating district standards for the use and implementation of technology.

Creating Standards

Standards are critical in our attempt to achieve cost savings, to reduce the possibility of purchasing several ons to the same problem, and to develop a uniform rm for delivery of technology services both within and among our buildings. In planning for technology, consider defining standards on a number of levels. We suggest the following:

Computer System Platforms
- Apple and MS-DOS coexistence
- Networking interface (i.e., Ethernet)

Applications Software
- Define district standards for instructional & administrative software

Voice and Video Applications
- Define standards from the type of telephone handsets to the format of VCRs, CD-ROM drives & videodisc players

The responsibility for planning and developing standards must be accepted by decision makers at both the district and building level. At the district level, recommendations should be created for a district-wide technology package or "architecture" that includes voice, data (text and graphics), and video. This recommendation must start at a conceptual level until a district-wide network is implemented.

In the short term, the local area network (LAN) architecture for each school must be defined, including the applications and users to be supported. This architecture should reflect the vision of what will be created as well as t status and short-term priorities and concerns.

Summary

Technology's promise of improving the teaching and learning environment can only be accomplished if the leadership and support is in place to allow it to happen. This requires constant review and involvement. The challenge for us, as educators, will be to develop and implement both long- and short-range plans that achieve this purpose.

At issue here is not whether students will learn to use technology, because they will no matter what we do in our schools. The important question for us as educational leaders is whether or not we want to be part of the solution. If we do not become involved as leaders in developing and implementing technology, others will step forward and do this for us. If this happens, the end product might not be something that promotes the best interests of students or education. We cannot provide the necessary technology unless we have a functional understanding of what we can accomplish through its use.

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References:
1. OTA. *Teachers and Technology: Making the Connection*, conducted by the Office of Technology Assessment for the United States Senate Committee on Labor and Human Resources. Washington, DC: U.S. Government Printing Office. April 1995.
2. Mergendoller, John R., et al., "Case Studies of Exemplary Approaches to Training Teachers to Use Technology," OTA contractor report, September 1994.
3. Costello, Ronald W., "Using Business Criteria to Make Technology Decisions in a School District," *T.H.E. Journal*, 21(4), November 1993, pp.105-108.
4. *Technology Study for Education: Noblesville Schools*, conducted by Ameritech Information Systems, Indiana Bell Telephone, completed in May 1992.
5. Tapscott, Don & Caston, Art, *Paradigm Shift: The New Promise of Information Technology*, New York, NY: McGraw-Hill, Inc., 1993.

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Lewis J. Perelman

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LEWIS PERELMAN, PRESIDENT OF KANBRAIN INSTITUTE, IS A RARE BLEND OF SCHOLAR, VISIONARY, AND PRAGMATIST. AN OUTSPOKEN CRITIC OF BOTH EDUCATION AND REFORM, PERELMAN IS CONVINCED THAT EDUCATION AS WE KNOW IT IS OBSOLETE AND IRRELEVANT IN TODAY'S WORLD AND WORKPLACE. AS A SENIOR FELLOW OF THE DISCOVERY INSTITUTE, HE WAS DIRECTOR OF PROJECT LEARNING 2000, A STUDY OF RESTRUCTURING EDUCATION AND TRAINING SPONSORED BY 12 U.S. CORPORATIONS AND FOUNDATIONS CONCERNED WITH FINDING WAYS TO MEET CONDITIONS LISTED IN WORKFORCE 2000. PERELMAN'S FIRST BOOK, *THE GLOBAL MIND* (MASON/CHARTER, 1976), NAMED ONE OF THE YEAR'S BEST SCIENTIFIC-TECHNICAL BOOKS BY *LIBRARY JOURNAL*, ANTICIPATED THE IMPACT OF THE GLOBAL INTERNET AND WORLD WIDE WEB. HE IS EXECUTIVE EDITOR OF THE BEST-SELLING *SCHOOL'S OUT: HYPERLEARNING, THE NEW TECHNOLOGY, AND THE END OF EDUCATION* (AVON BOOKS, 1993), BASED IN PART ON HIS WORK AS A SENIOR RESEARCH FELLOW OF THE HUDSON INSTITUTE, WHERE HE SERVED FROM 1989 TO 1992 AND WORKED ON THE WORKFORCE 2000 PROJECT SPONSORED BY THE U.S. DEPARTMENT OF LABOR. PERELMAN HAS WRITTEN ARTICLES FOR *BUSINESS WEEK*, *FORBES*, *WIRED*, AND *THE WALL STREET JOURNAL*.

Five years ago, your bombshell book School's Out *was published. How has it held up?*

The basic argument—that academia is an obsolete institution in the emerging knowledge-age economy—is solid. Some of the technical details have become dated, of course. I used George Gilder's term *telecosm* but did not explicitly mention the Internet, and the Web was essentially unknown at the time I was writing. I also noted that the Japanese were pushing the advancement of robotics to cope with Japan's acute labor shortage; subsequently the Japanese economy fell into an ongoing slump [that] has greatly increased unemployment and dislocation and eased that particular pressure. And much of the book's policy discussion targets the foibles of the Bush administration. I had intended to mention that Bill Clinton was the most active Democrat collaborator in those erroneous policies, but that was one of those revisions that never made it past the publisher's deadline. Overall, though, I think my argument was perhaps too cautious. The policy prescription could have stated an even stronger case for privatization. Also, the trends toward the growth of the hyperlearning environment and the displacement of academia have moved along farther and faster than what I suggested then.

In what way?

Well, the whole Web thing has been amazingly dynamic, even to those of us who thought we were ahead of the curve. And, of course, this is still only the beginning. But it continually strikes me how rapidly people in general have absorbed as a normal feature of their world what is really a radical transformation of communication, commerce, and ultimately culture. For instance, I gave a speech a couple of years ago to a Chamber of Commerce conference on school reform in Columbus, Ohio. The night before, I was taking a stroll to relax and I noticed on the corner of the central square a huge billboard on top of the high-rise office tower of Huntington Bank. The only thing written on it was "<http://www.huntington.com>." The next day I asked the audience of 400 or so people how many knew what that meant, and essentially every hand went up. Then I asked how many would have understood that sign a year earlier and only a few hands went up. Finally, I asked how many people there could identify Tim Berners-Lee.

The inventor of the World Wide Web.

Right. Only one person in the hall knew that.

But you said it was a school reform conference. Why would you expect that audience to be aware of his name?

I didn't. That was my point. The meeting was planned to give attention to supposedly important achievements in school reform. But Tim Berners-Lee has done more to transform the world of learning, knowledge, and work than all the supposed "big name" heroes, experts, and champions. This is just one example of the point I tried to make in my book: that the forces that are changing academia in the direction of obsolescence and ultimate extinction are almost completely unrelated to anything or anyone found in education policy or education reform.

But many people seem to view you as a reformer, maybe even a radical reformer.

That's one of the main frustrations and disappointments I have about the whole process related to the book. I wrote it mainly for a business audience, to explain how technology is spawning a new relationship between work and learning in a knowledge-based economy. Of course this transformation has sweeping implications for human resources, business processes, management, investment, and ultimately policy—the most dramatic of which may be the obsolescence of an education sector that currently absorbs over $600 billion of the U.S. economy. I'm often invited to speak to groups concerned with reform of education or training. But I always take pains at the outset to emphasize that I am not a reformer: that is, someone who thinks that education worked great in 1953, and "you people" (whoever) have fouled it up, and I'm here to fix things.

Actually, I recall you said in the beginning of School's Out *that you thought the U.S. has the best education system in the world.*

I still do. And overall our education system is doing a better job than ever, given what we want and expect and what we value. The problem is not that educators are doing a worse job than ever before—it's that most of them are still doing the same job. The vastly different technological and economic fabric of the 21st century eventually will lead most people to want, expect, and value something else, leaving academia with only a tiny demand and constituency.

Education reform over a period of decades has proven to be either unnecessary, futile, irrelevant, or even downright harmful.

Certainly our established systems today are still far from your hyperlearning model. But do you really feel that genuine reform is impossible, that we must abolish education and completely start over?

Yes and no. I'm not only not a reformer, I have no interest in reform; and, when asked, I discourage others from wasting time and money on it. Education reform over a period of decades has proven to be either unnecessary, futile, irrelevant, or even downright harmful. But the press and others often leap from that to the simplistic conclusion that I advocate abolishing schools and education.

But haven't you implied that?

Not at all, ever. I've analyzed and forecasted trends that, I am increasingly confident, will lead eventually to the collapse of the academic system in a way and for reasons that are basically the same as those that led to the collapse of the Soviet system. That's prognosis, not advocacy. By the way, since *School's Out* was published, basically the same view of academic obsolescence has been echoed by a growing cadre of opinion leaders: Arthur C. Clarke, Peter Drucker, Seymour Papert, Stan Davis, John Seeley Brown, Roger Schank, Richard Saul Wurman, columnists in *The Wall Street Journal* and *Financial Times*, the publishers of *Wired*, and others.

A lot of educators and those called reformers think, to the extent you may be right, that that's a real loss, a serious failure. They must be confused when you say that our education system is better than ever and the best in the world but, on the other hand, it's doomed to collapse. And moreover that you seem to welcome that as progress.

It's not a matter of failure or blame. Reformers are obsessed with better or best. They don't recognize that those notions don't mean much when you are dealing with major global system changes. There's a story from modern industrial history that I have found helps to get these distinctions across. In 1952, the U.S. government decided that this country needed to have the best, biggest, and fastest transatlantic steamship. The government learned that the British liners *Queen Mary* and *Queen*

Elizabeth had proven to be invaluable strategic assets as troop carriers during World War II. So the government had Newport 'ews shipyards build and launch the SS *United States*. On its ıaiden voyage, the SS *United States* set the all-time maritime speed record for crossing the Atlantic: a little less than 84 hours, nearly a third faster than the record set by the *Queen Mary*. But in that same year, a British airline introduced the first jet passenger plane, the de Havilland Comet, which, within a couple of years, was carrying people across the Atlantic in under six hours. The SS *United States* lost money every time it sailed; and the ship, designed for 30–40 years of service, was bankrupt in 12 years and spent the next quarter century rusting away at a pier in Turkey.

Whatever may improve education matters little if what people need and want is something else.

So you're saying that because hyperlearning is as superior to classroom education as the jet was to the steamship, academia is doomed to be driven out of business. But many educators and analysts argue that multimedia, distance learning, and all that really are no better for education than the traditional classroom. Todd Oppenheimer, for instance, made that case in a recent article in The Atlantic Monthly *(July 1997).*

s, and the point of the SS *United States* story is that such arguıents over better and best are largely irrelevant to the economic dynamics at work in this kind of system shift. Whatever may improve education matters little if what people need and want is something else. To see that, first note, particularly in regard to foolishness like national education goals, that the SS *United States* fully achieved the government's national goal of building the best transport ship of its kind in history, in the world.

But the "best" wasn't really good enough.

It was plenty good enough. It just was the wrong "best." There is no way you can say the Newport News shipbuilders failed. They were the best in the world and they built the best ship in the world. They didn't need to be reorganized or retrained or any of the usual nostrums of reform. They increased the top speed of a transport ship from around 30 knots to over 40 knots—a huge improvement. But there was no way then or now to get a ship to go 500 knots.

Granted, the jet was a much faster form of transport. But many people still like to travel by ship; in fact it's a booming business. It didn't disappear. Yet you claim that hyperlearning spells the end of education. Most people feel that digital media can't match quality of the classroom experience.

ıl confess that the "end" or extinction of education is a bit of an overstatement. It would be more accurate to say the end as an important economic or social phenomenon, a collapse to triviality. In any case, that word *experience* holds the reason why "better" is too fuzzy a notion to be relevant to a major system transformation. Is it "better" to travel by jet plane or by ship? The right answer is: it depends. If you have to get from New York to Paris by tomorrow to sign a contract or a treaty, then it's not a question of better. It's no contest: the plane is the only real option. However, if you want to enjoy the experience of the finest ship's amenities—restaurants, swimming pools, nightclubs, sea breezes, and romantic sunsets—again, there's really no contest.

So why can't hyperlearning and schooling just coexist?

Because in the ecology of an economic system, one technology can have competitive and market effects on another that make one unsustainable, or that require such drastic reengineering that what results is really a replacement more than a revision of what was obsolete. In the economy of the great transatlantic steamships, the first-class opulence that defined the public and historic image of those vessels was in fact subsidized by the fares of the steerage passengers—literally, the "huddled masses" celebrated by the Statue of Liberty—who simply wanted to get from one side of the ocean to the other, as cheaply and quickly as possible. Some ships also were subsidized by national governments. Once those steerage passengers were siphoned out of the steamship market by the airplane, there weren't enough passengers who mainly wanted the "experience" of ship travel to pay the full cost of providing it. The benefits could no longer justify the soaring cost of government subsidies either. That's why the SS *United States* was a bust from the start. As for today's booming cruise ship industry, it's really a mistake to view that as an heir to or continuation of the pre–World War II ocean liner industry. The casual observer might assume that a ship is a ship and that ships are media of transportation. But a state-of-the-art cruise ship like the Carnival lines' 103,000-ton *Destiny* that now plies the Caribbean is not really in the transportation business.

That word *experience* holds the reason why "better" is too fuzzy a notion to be relevant to a major system transformation.

Should we categorize them more as entertainment, then?

Of course. The *Destiny* is about three times bigger than the SS *United States* and architecturally has far more in common with a Las Vegas hotel. But it won't set any speed records. It's profitable because it doesn't waste money on fuel-guzzling engines and an iceberg-fending hull. Its passengers aren't in a hurry to go anywhere—in fact, they aren't trying to get anywhere.

Your implication seems to be that hyperlearning will take away much of the economic base of education; but on the other hand, education may be able to reinvent itself as the cruise ship business did.

That's roughly right. But the analogy has some crucial limitations. You didn't have the great majority of the U.S. population compelled by a combination of law, constitutional edicts, and endemic workplace discrimination to spend 12 to 20 years of their lives incarcerated in ocean liners. If you had, the development of the air transport industry would have been severely retarded, because passengers would not have been as free to choose a new system that worked much better to meet their needs. The financial and human capital needed to grow the aviation industry would have been expropriated to be wasted on obsolete shipping lines. And the sheer number of people dependent on the compulsory ocean travel boondoggle would have formed a demosclerotic lobby to oppose the deregulation and privatization policies needed to break that logjam.

What do you mean by a "demosclerotic" lobby?

The term reeks of hospital wards rather than committee rooms. But that is author Jonathan Rauch's point: that it is a disease of democracy, government, and nations that all but cripples national policymaking. In a sense, it's policy-wonk-speak for a new interpretation of gridlock. Fortunately, though, there's probably more kick left in angry U.S. voters than either sclerosis gurus or Washington lobbyists believe.

So that is your view of the current economy of education?

It's a thumbnail sketch of any socialist system, including education.

> The people most dependent on government subsidy wind up experiencing more of the pain of market opening.

You continually equate education with socialism. Isn't that too inflammatory?

There's nothing personal about that. I'm just trying to be accurate. Over 90 percent of the U.S. education economy is owned, controlled, funded, subsidized, or regulated by government. In most countries, it's more like 100 percent. If that is not socialism, then the term has no meaning.

And you see no way to change it?

Oh, change is inevitable. The last century of history shows that such socialist economies are bound to drive themselves to bankruptcy. But the pattern of change is different from and far more costly than that of a market economy. The overall impacts of government compulsion, regulation, and subsidy are to multiply the pain and delay the gain from technological and industrial innovation. The greater the scope and duration of government control, the bigger the cost of privatization, deregulation, and demonopolization. The people most dependent on government subsidy wind up experiencing more of the pain of market opening—because they've been deprived of the opportunity to adapt their knowledge, skills, technology, and ventures to real market conditions.

> Political leaders have as much chance of dictating or foretelling the future knowledge market as the future stock market.

But even if government should stop owning or providing educational services, isn't there still a need to set goals or standards for what people need to learn? Why do you dismiss that as foolishness?

Because political, bureaucratic processes are as incapable of knowing the what of learning as they are the how. Even more so when they are presuming to extrapolate, to project what know-how people are going to need in the future. The standards of knowledge and know-how are set by the interplay of culture and markets. Any effort by government to decipher and then mandate those things can only introduce debilitating distortions. You would not tolerate Al Gore—or for that matter Newt Gingrich—dictating what stocks you have to own to meet your financial investment goals over the next 20 years. Yet you are supposed to trust his ilk to decide what knowledge assets you or your kids are supposed to invest in over the same span. Political leaders have as much chance of dictating or foretelling the future knowledge market as the future stock market.

Then why did more than 200 Silicon Valley chief executives endorse the Clinton administration's education goals program earlier this year?

I can answer that in two words: Bill Lerach. He's the lawyer who has tormented high-tech companies with shareholder lawsuits whenever their performance falls short of expectations. When Clinton turned out to be, shall we say, ambiguous in his support of the California Proposition 211 campaign led by venture capitalist John Doerr and that group to protect themselves against Lerach and his fellow jackals, the Doerr bunch decided they needed to play the political games they traditionally found boring and irrelevant. So, to lubricate Clinton to take a more congenial stance on key industry goals in areas such as encryption, they chose to squirt a little PR oil on his education goals hokum.

Do you really believe they are that cynical?

Oh, I suppose more than a few of that group are sincere, for what that's worth. But I doubt if any of them have ever given any education issue more than a few minutes of critical thought, if that much. In any case, there's no reason to assume that at any given moment the current CEOs of the supposedly major high-tech companies necessarily have a clue as to what the real best interests of their companies are. Just ask the employees and stockholders of Apple, Digital, Novell, Informix, or AT&T. I

don't mean to tar all such executives as incompetents. The point is that it is clearly very hard to succeed, and easy to fail, in the business that they supposedly know. Just because they have eaten food all their lives, I think most of them would not presume to know how to run a farm or a restaurant chain. So just because they went to school, or dropped out in some cases, why assume they know how to run education? Let's face it, when you see a Gil Amelio get paid $5 million to stop running Apple Computer, having lost another $1.5 billion of stockholders' already depleted wealth, you have to wonder how much credence or sympathy such people really warrant.

We recognized a couple of years ago that knowledge had become the major source of value and wealth in the modern economy.

In your book you wrote about hyperlearning. More recently you coined the term kanbrain, *which Tom Peters honored as the Idea of the Year. Now you are publishing a newsletter on knowledge management. Which of those three is the force that you see toppling the economy of education?*

I suppose all of them. Each is a way of slicing the same basic phenomenon. As I said, I was frustrated that the publisher and therefore many readers thought my book was about school reform, when it really was concerned with everything beyond and instead of school.

So why did you call it School's Out?

Actually, the title I originally gave it was *The Mindcraft Economy* but the publisher thought *School's Out* was more provocative. Anyway I coined "hyperlearning" to put a label on the web of postacademic knowledge processes that is the driving force of the new economy. Later, when I was working on an article for *Forbes* about how this transformation was taking root in the corporate world, John Seeley Brown, the research director of Xerox, told me he thought hyperlearning was not such a good term.

Why is that?

Because, as he put it, when average corporate managers hear the word *learning*, they reflexively get the mental image of classroom, teacher, textbook, lecture, and such. So, in the work they do on what I called hyperlearning, he and his colleagues try to avoid using *learning* or any term suggestive of academia. This just bears out my argument that this new thing, whatever you call it, is not that.

So you replaced it with kanbrain. *Which means what, exactly?*

I had found that the leading edge companies I had studied, like Hewlett Packard, Intel, and others, were rapidly getting rid of their corporate classrooms and replacing them with the sort of multimedia mesh I associated with hyperlearning in the book. All aimed to replace preparation-oriented education and training processes with learning; and the knowledge-support process provided on-demand, just-in-time, just-enough, anywhere, anytime. I found that the architects of these new systems were particularly prone to that phrase "just-in-time." They saw, correctly, that the systems they were constructing were doing to knowledge what the just-in-time delivery processes the Japanese called *kanban* had done to material resources and goods in manufacturing. So as a new label for the subject of the *Forbes* piece, I rather unimaginatively combined *kanban* and *brain*.

Is that also the subject of your newsletter Knowledge Inc.?

Among several other things. We recognized a couple of years ago that knowledge had become the major source of value and wealth in the modern economy. Overwhelmingly. Peter Drucker explained this lucidly (as usual) in his book *The Post-Capitalist Society*, notwithstanding the somewhat misleading title. He meant that the old physical notion of capital was obsolete. The sources of wealth defined by traditional economics—land, labor, and capital—can't account for more than a fraction of the market value of a company like Microsoft. Even in manufacturing today, 80 percent or more of the typical company's market value is found in the form of what economists traditionally called "intangibles." That's really just a fancy term for leftovers. What could not be accounted for, in hard numbers, as real estate, labor costs, or financial assets and liabilities until recently was just thrown into the stewpot of intangibles or the accountant's goodwill. If there is a definitive sign of the change from an industrial to a postindustrial economy, it's that the leftovers went from being a garnish to being the lion's share of the meal. In the case of the virtual corporation, they are just about the whole meal.

If you steal my microchip design, I still have it, but the economic loss may well be worth more than if you hijack a whole ship full of computers.

So now that's knowledge?

Well, it's obvious that the immense value of a Microsoft derives from the particular ideas expressed in the intangible information of software. And from some combination of the special abilities, know-how, and character of the company's employees and leaders; its particular organization; its relationships with customers, suppliers, competitors, and allies; and its overall culture. It's become trendy in the '90s to speak of these things in terms of organizational learning, or intellectual capital, or simply knowledge. At the same time, the economics and business textbooks have almost nothing to say about how this kind of economy works or how it can be managed. Moreover, the theory and rules of knowledge and knowledge-based enterprise are clearly very different. For instance, if you steal my microchip design, I still

have it. but the economic loss may well be worth more than if you hijack a whole ship full of computers. Or this: I just read about a company that fired an employee because he refused to reveal an original idea he had for a software product unrelated to their business. They are now suing him to force him to turn over the idea the company claims to own, even though they don't know what the idea is. In spite of this sort of confusion, or perhaps because of it, sheer economic necessity has driven a growing legion of companies and entire industries to try to find ways to manage these knowledge issues profitably. We've been tracking these efforts and the lessons learned in our newsletter for over a year now.

Education cannot adapt because it has outlawed adaptation.

So, how are those developments going to lead to the collapse of education?

I don't much believe in forecasting, the world being an inherently chaotic system. But the forces leading in that direction are already here, and it's not hard to guess how they may play out. First, more and more businesses are going to be driven by exploding technological opportunity and competitive necessity to make the sort of kanbrain shift I mentioned, initially by replacing corporate classrooms with real-time knowledge systems. A few years ago, I wrote about the case of Hewlett Packard. By replacing over 90 percent of classroom training with a mix of knowledge-support systems, HP wound up cutting the cost of enabling its sales people to sell a new product by about 98 percent. We've reported similar developments more recently in such companies as Silicon Graphics and Sun Microsystems. That leap is even more dramatic than the one from steamship to jet plane. The competitive pressures in the IT industry are such that once one player gets that kind of cost and performance advantage, you either get with the program or perish.

At the same time, we see a growing number of companies trying in various ways to organize and formalize their management of knowledge, learning, and intellectual capital. The initiative may come out of the information systems department, or marketing, or engineering. Often it's led by finance, because they have the bottom-line responsibility to literally account for the costs and value of whatever the business does. Some organizations even have created new positions like chief learning officer or chief knowledge officer. All these innovations are questionable, some are pure hype, and most will fall short or fail miserably. But the churn of the market will progressively refine and define some reasonably effective rules and practices. Part of the pattern I see is that the ownership of knowledge, learning, and cognitive processes is moving away from the "human resources" enclave into the more central management and productive operations of the business. A telling symptom of the sweep of that movement is the building rush of HRD and training and development professionals to reinvent and rename themselves as "performance consultants." Ironically, I just received a brochure for a seminar on this. It promises me that, for my 300 bucks, I will learn how to "contract for RESULTS, not just training activities," and "distinguish your roles: internal performance consultant vs. trainer." I'll dare to semi-predict that we will see, before long, some of the big human resource and training associations adopt new names. And in fact, most of their members will be adapting to new roles, skills, and careers.

Why couldn't educators adapt in the same way?

Because most of those business staffers' employers are increasingly driven by market forces to pay only for results, not just activities. Because those corporate trainers' students are not compelled by law to attend their classes. And because the trainers have no tenure. Education cannot adapt because it has outlawed adaptation. Education reformers hold testimonial dinners and hand out awards for improvements of a couple of percentage points in test scores or dropout rates or such. And rightly so, given the hard slog the champions of such efforts have to go through to get anything done. But in the market economy, companies like those I've mentioned are achieving order-of-magnitude improvements in knowledge-process productivity—in months rather than decades.

Even if education can't match that kind of innovation, why should this prized institution of knowledge and culture collapse? Won't we lose more than we gain as a society?

These business forces ultimately will reshape the whole social ecology in which academia is embedded. The same transformations I've noted will lead businesses to progressively abandon the vestiges of academic credentialism in their employment practices, as it becomes more feasible to identify, measure, certify, recruit, and manage specific human skills. We see some examples of that now. Companies that are using software to manage the inventory of their workforce's skills. Others using simulations to observe and assess actual work performance instead of diplomas. The boom of IT certifications such as Certified Novell Engineer or Microsoft Certified Software Engineer, which have no attendance or credit-hour requirements. Advancing technology and visible successes will advance this trend. As companies reinvent these basic systems, swaths of adult employees will have it impressed on them that the traditional rules linking learning, work, and economic success have been replaced by a whole new game—call it hyperlearning, kanbrain, whatever. The next thing that happens, that is happening, is a sort of epiphany. They realize that their kids are better at "it" than they are. Also that the school is not "it," that the more the kid gets "it," the more trouble the kid seems to have with school, and so on. That population of families may be marginal now but it's growing, fertilized by the technological and market transformation of what "making a living" means. Once they attain a politically critical mass, the industrial-academic age will come to an end, much as the Cold War did.

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Have you seen that happening already? Do you see such people here now?

Since the publication of *School's Out*, I've heard from and met them continually. One of the first was a systems engineer in New Jersey who wrote me saying, "The school said our nine-year-old son is learning disabled, but he works with me at home on the Mac and is better at it than I am. We know he is really talented. They just don't get it. So we've become home schoolers."

The attempt to shoehorn hyperlearning media into the arthritic skeleton of academia is as much a chimera as trying to merge the internal combustion engine with the horse.

Do you think that home schooling is the trend—or an answer to the problem?

It's a symptom. It's really nonschooling, you know. Home schooling is a cover families need to keep the sheriff away. Whatever it is, it's changing. When it was mainly a preference of religious fundamentalists, there was a stigma of abnormality. As it becomes a practice of high-tech yuppies, of leaders and winners and the "cool" people, the social nature changes. As you get a sufficient mass of such people—families who rather than being isolated become a community, even a majority (which is happening now in some places here in Virginia)—the process itself changes. Further integrating and transforming factors are the Internet and the Web.

But where does that leave traditional teachers? Do they need to be retrained in multimedia and distance learning methods? Do you see any role for them at all in this future system?

The simplest answers are: nowhere, no, and none. But that doesn't reflect the real complexity of the questions you are asking. First, what does the phrase "traditional teachers" mean? If you mean people who currently hold supposedly instructional jobs in the government-controlled academic sector, many of them, especially the younger ones, are trying to be very much not "traditional" in their craft—as the simple phrase puts it, trying to be the "guide on the side" instead of the "sage on the stage." But those people are often subjected to an acute political backlash from critics who view whatever it is they are doing as "not education" or "not teaching." Of course, *School's Out* argues that those critics are right—the modern craft of learning and knowledge is not school or education. Unfortunately, the attempt to shoehorn hyperlearning media into the arthritic skeleton of academia is as much a chimera as trying to merge the internal combustion engine with the horse. As for those who still want to adhere to what they think of as "traditional" processes and institutions, I'll concede that, after the collapse or big shift, there still will be some demand for that, perhaps for decades, just as there still is some demand today for blacksmiths, stables, fox hunts, cattle drives, and other artifacts of the equestrian age. Let's also keep in mind that the majority of people in the U.S. who could be considered "teachers"—in the sense of having held a faculty position, or having the credentials or even better the abilities and interest to be in the craft of helping people to learn—are not currently working in traditionally defined teaching jobs. Generally they found out, sooner more than later, that serving the needs of learners and serving the requirements of academic bureaucracies are contradictory and mutually exclusive missions. In that sense, the growing list of "school Sakharovs" like John Taylor Gatto who have signed up with the Alliance for the Separation of School and State is arguably more representative of teachers than the National Education Association.

Are you saying that people who are currently employed in education have no future?

I'm pretty sure that, as individuals, just about all of them have a future, if you mean economically. What exactly that future is, either individually or collectively, I have no idea. Only the workings of the free market can determine that, which is why I see the most talented and ambitious educators bailing out of the academic state farm to make it in the real world. People can be highly enterprising and adaptive when they have the need and opportunity. Six years into the post-Soviet era, more than half the Russian workforce now works in the private sector. Thousands of Americans employed in military and defense work were clobbered by the end of the Cold War, especially in California. But, after a tough period, those people and that economy are now rebounding, seizing the growth opportunities spawned by the combination of fermenting technology and the hundreds of billions of dollars freed from government control.

As I suggested earlier, the longer our government keeps the U.S.'s $600-billion academic sector and its denizens insulated from the market economy, the more economically crippled they will become, and the deeper will be the difficulty of ultimately adapting to market forces. Anyone who wants to argue that should first visit Belarus, or even just chat with the veterans in a telephone, cable TV, or electric utility company who are struggling to make it in a competitive marketplace after decades of regulatory protectionism. The sooner and more thoroughly we do to state education what most of the world has accepted as necessary in other state industries—manufacturing, mining, housing, telecommunications, transportation, electricity, and other would-be utilities—the better off everyone involved is going to be. If we have come to recognize that government is not competent to manufacture TV sets, to run an airline, to provide efficient communications services, to make movies, or to deliver a package (much less the news), why would we think these same people and bureaucracies are capable of managing the single most complex phenomenon in the known universe—the human mind? Actually, when I posed that question at a news conference in Germany a couple of years ago, the western German reporters thought the implication that government should get out of the

education business also was obviously valid. Only some diehard socialists among the eastern German press were incensed that the question could be raised at all.

With all the new findings and ideas you've raised, will there be a second edition of School's Out? *Do you have a new book in the works?*

Many people have asked for a revised and updated version of *School's Out*, but so far the funding necessary to get the work done has not been provided. I'm gradually constructing a new publication from bits I've written for our newsletter and other publications like *Wired* and *Fast Company*, focused on the new rules of what I call knowledge-effective enterprise. I'm also consulting with some organizations that seriously want to push the edge of the envelope. For instance, I'm now working with a group headed by Peter Denning at George Mason University here in Virginia to build an on-demand hyperlearning program to ease the skills crunch in this region's booming high-tech economy. I hope we can extend that capability to benefit more than just the technical elite. I've also worked for a couple of years with a group of friends here to create a foundation to help disadvantaged kids and their families get in on the promise of this new economy. But even though many people liked the idea, we haven't found a funding source to enable us to launch it.

What was the idea?

We would call it the Tools of Hope Foundation. The mission very simply would be to get advanced technology into the hands and homes of disadvantaged kids and their families—beta-version stuff, not hand-me-down relics. And the cash to shop for what they want, not someone's surplus equipment. The aim would not be charity or a giveaway. The concept would be more of a loan than a grant, with the expectation that it would eventually be paid back by using the "tools of hope" for entrepreneurship, to create wealth. A kind of knowledge-age Junior Achievement. ◀

The teacher is an appendix of the classroom/textbook/lecture model of learning, which is technologically obsolete. In the new hyperlearning enterprise, there may for a while be a role for human facilitators or coaches, but it probably will not be a profession or sole vocation, and certainly will be incompatible with the perpetuation of tenure and unions.

—Lewis J. Perelman, IBM 's Multimedia Today, *Vol. 3, No. 4*

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Lewis J. Perelman (*kanbrain@concentric.net*) is executive editor of the management newsletter, *Knowledge Inc.* (*www.knowledgeinc.com*). *School's Out* is available from *amazon.com*.

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R U B R I C S

f o r t h e

A s s e s s m e n t
o f
I n f o r m a t i o n L i t e r a c y

Based on the Information Literacy Guidelines
for
Colorado Students, Teachers
and
School Library Media Specialists

cde
Colorado Department of Education

State Library and Adult Educatio n Office
201 E. Colfax Avenue
Denver, CO 80203

CEMA
Colorado Educaitonal Media Association

6/96

An explanation of rubrics, and their application in standards education

The Information Literacy Rubrics are an extension of the Model Information Guidelines (1994; Colorado Department of Education. State Library and Adult Education Office. Colorado Educational Media Association).

A rubric is a descriptive measurement for defining what a learner should know, and can do. This document was created to define the knowledge and ability of every student in how they:

- Construct meaning from information.
- Create a quality product.
- Learn independently.
- Participate as a group member.
- Use information and information technologies responsibly and ethically.

The rubrics are designed in a *matrix*, or grid of benchmarks which define the information literate student. The far left column contains the *Target Indicators*, or the individual components of each of the five information literacy guidelines. Each target indicator is followed by four qualities, or key behavior skills, to be measured. These are written in student language, beginning with a minimal level of understanding, labeled In Progress, followed by Essential, Proficient, and Advanced. Page 1 is an overview for all five guidelines; pages 2 - 8 address specific benchmarks. The final page is a checklist for a student or teacher which may be used in the assessment process.

It should not be a goal to have each student attempt to achieve the Advanced level in each skill area on each project. Rather, the goal should be to assess students on the *key points* important to the specific content area task, and *understand the process* for applying that skill in other curricular work. [Example: In a task involving the knowledge seeking process, the student might first be assessed in determining information needs, and acquiring the information. In a later task, they could be assessed in the organization, processing, and evaluation of the information].

The ideal application and use of these assessments is in a collaborative curriculum involving the student, teacher, media specialist, and other stake holders in the school environment. These rubrics can be used as written to define information goals for the student, or as a framework for student/teacher-written assessments. They are applicable to all grades and content areas, but only through a cooperative effort between the key players will they be truly effective in ensuring student buy-in to understanding the information literacy process.

Knowing how to apply these skills is necessary for successful living in the twenty-first century, and beyond.

Information Literacy Rubrics Writing Team, Dec.-Jan. 1995

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International Society for Technology in Education

ISTE Recommended Foundations in Technology for All Teachers

Standards Introduction | ISTE Home Page

I. Foundations. The ISTE Foundation Standards reflect professional studies in education that provide fundamental concepts and skills for applying information technology in educational settings. All candidates seeking initial certification or endorsements in teacher preparation programs should have opportunities to meet the educational technology foundations standards.

A. Basic Computer/Technology Operations and Concepts. Candidates will use computer systems run software; to access, generate and manipulate data; and to publish results. They will also evaluate performance of hardware and software components of computer systems and apply basic troubleshooting strategies as needed.

1. operate a multimedia computer system with related peripheral devices to successfully install and use a variety of software package.
2. use terminology related to computers and technology appropriately in written and oral communications.
3. describe and implement basic troubleshooting techniques for multimedia computer systems with related peripheral devices.
4. use imaging devices such as scanners, digital cameras, and/or video cameras with computer systems and software.
5. demonstrate knowledge of uses of computers and technology in business, industry, & society.

B. Personal and Professional Use of Technology. Candidates will apply tools for enhancing their own professional growth and productivity. They will use technology in communicating, collaborating, conducting research, and solving problems. In addition, they will plan and participate in activities that encourage lifelong learning and will promote equitable, ethical, and legal use of computer/technology resources.

1. use productivity tools for word processing, database management, and spreadsheet applications.
2. apply productivity tools for creating multimedia presentations.
3. use computer-based technologies including telecommunications to access information and enhance personal and professional productivity.
4. use computers to support problem solving, data collection, information management, communications, presentations, and decision making.
5. demonstrate awareness of resources for adaptive assistive devices for student with special needs.
6. demonstrate knowledge of equity, ethics, legal, and human issues concerning use of computers and technology.
7. identify computer and related technology resources for facilitating lifelong learning and emerging roles of the learner and the educator.
8. observe demonstrations or uses of broadcast instruction, audio/video conferencing, and other distant learning applications.

C. Application of Technology in Instruction. Candidates will apply computers and related technologies to support instruction in their grade level and subject areas. They must plan and deliver instructional units that integrate a variety of software, applications, and learning tools. Lessons developed must reflect effective grouping and assessment strategies for diverse populations.

1. explore, evaluate, and use computer/technology resources including applications, tools, educational software and associated documentation.
2. describe current instructional principles, research, and appropriate assessment practices as related to the use of computers and technology resources in the curriculum.
3. design, deliver, and assess student learning activities that integrate computers/technology for a variety of student group strategies and for diverse student populations.
4. design student learning activities that foster equitable, ethical, and legal use of technology by students.
5. practice responsible, ethical and legal use of technology, information, and software resources.

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International Society for Technology in Education

Standards for Advanced Programs in Educational Computing and Technology Leadership

Standards Introduction | ISTE Home Page
Advanced Specialty Content | Advanced Professional Preparation

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Prerequisite Preparation.

As a prerequisite to the advanced program, candidates must document knowledge and competencies contained in the Educational Computing and Technology Literacy matrix.

1.0 Foundations.

Professional studies in basic educational computing and technology literacy builds a foundation for applying computers and related technologies (hardware and software) in educational settings. The advanced program must document the prerequisite preparation of the candidates or provide instruction to fulfill the Foundations guidelines in the initial coursework.

2.0 Specialty Content Preparation in Educational Computing and Technology Literacy.

Professional studies in basic educational computing and technology literacy provide concepts and skills that prepare teachers in the specialized and professional content for teaching educational computing and technology literacy and to use technology to support other content areas. Advanced programs must document the prerequisite preparation of the candidates or provide instruction to fulfill the educational computing and technology literacy guidelines in initial coursework.

3.0 Professional Preparation in Educational Computing and Technology Literacy.

Professional preparation in educational computing and technology literacy prepares candidates to integrate teaching methodologies with knowledge about use of technology to support teaching and learning. Advanced programs must document the prerequisite preparation of the advanced candidates or provide instruction to fulfill the educational computing and technology literacy guidelines in initial coursework.

4.0 Specialty Content Preparation for Educational Computing and Technology Leadership.

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Professional studies in educational computing and technology leadership prepare candidates to exhibit leadership in the

identification, selection, installation, maintenance, and management of computing hardware and software and the uses of computers and related technologies throughout the curriculum.

4.1 Research and Theories.

Candidates will identify and apply educational and technology-related research, the psychology of learning, and instructional design principles in guiding use of computers and technology in education.

4.1.1 summarize and apply principles and practices of educational research in educational technology.
4.1.2 summarize major research findings and trends related to the use of technology in education to support integration of technology in a K-12 environment.
4.1.3 apply theories of learning, teaching, and instructional design and their relationship to the use of technology to support learning.
4.1.4 describe social and historical foundations of education and how they relate to the use of technology in schools.
4.1.5 identify research related to human and equity issues concerning the use of computers and related technologies in education.
4.1.6 design a research project that includes evaluating the use of a specific technology in a K-12 environment.

4.2 Instructional Design and Product Development.

Candidates will evaluate authoring and programming environments for use in the classroom. They will apply instructional design principles to develop, implement, and test interactive multimedia instructional products using authoring environments.

4.2.1 use and apply more than one computer authoring and/or programming environment.
4.2.2 describe the characteristics and uses of current authoring environments and evaluate their appropriateness for classroom applications.
4.2.3 describe the characteristics and uses of current programming and scripting environments and evaluate their appropriateness for classroom use.
4.2.4 apply instructional design principles to the design of screens, text, graphics, audio, and video in instructional products under development.
4.2.5 describe and practice strategies for testing and evaluating instructional products designed.
4.2.6 apply instructional design principles to develop substantive interactive multimedia computer-based instructional products.

4.3 Information Access and Delivery.

Candidates will implement information access and delivery resources in K-12 schools to support the curriculum.

4.3.1 identify and use information access and telecommunication tools to support research and instruction throughout the curriculum.
4.3.2 use and implement distance learning delivery systems including computer, audio, and video conferencing.

4.3.3 create multimedia presentations using advanced features of a presentation tool and deliver them using computer projection systems.
4.3.4 install, configure, and use local mass storage devices and media to store and retrieve information and resources.
4.3.5 describe issues related to selecting, installing, and maintaining WANs for school districts.

4.4 Operating Systems.

Candidates will install, customize, and configure the operating systems of computers and computer networks in school settings.

4.4.1 identify and describe the major operating systems associated with computing platforms found in K-12 schools.
4.4.2 identify and manipulate preferences, defaults, and other selectable features of operating systems commonly found in K-12 schools.
4.4.3 use and manipulate net-working software to effectively manage the operation of a LAN.
4.4.4 evaluate, troubleshoot, install, and maintain computer operating systems for classrooms and laboratories.

4.5 Software/Hardware Selection, Installation, & Maintenance.

Candidates will identify and implement software in both classroom and administrative environments. They will investigate issues related to school/site planning, purchasing, and technology integration.

4.5.1 identify and describe software used in classroom and administrative settings including productivity tools, information access/ telecommunications tools, multimedia/hypermedia tools, school management tools, evaluation/portfolio tools, and computer-based instruction.
4.5.2 investigate and recom-mend purchasing strategies and procedures for acquiring administrative and instructional software for educational settings.
4.5.3 describe evaluation criteria for software and identify reliable sources of software evaluations.
4.5.4 identify and implement methods of installation, mainten-ance, inventory, and manage-ment of software libraries.
4.5.5 develop and implement ethical and legal procedures for maintaining software libraries.
4.5.6 identify and classify adaptive assistive hardware and software for students and teachers with special needs and locate sources to assist in procurement and implementation.

5.0 Professional Preparation in Educational Computing and Technology Leadership.
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Professional studies in educational computing and technology combine leadership skills and concepts with knowledge about use of computers and related technologies in schools. Advanced programs preparing educators for a specialty in educational computing and technology require studies of and experiences with leadership, staff development, and supervisory concepts and skills as they relate to use of technology-based systems in K-12 education.

5.1 Instructional Program Development.

Candidates will develop curricular plans based on local, state, and national standards for the use of computers and other associated technologies.

5.1.1 describe and analyze accepted principles of strategic planning to facilitate curriculum design for teaching with comput-ers and related technologies.
5.1.2 identify and use national, state, and local guidelines to develop curriculum plans for integrating technology in the K-12 environment.

5.2 Teaching Methodology.

Candidates will apply effective methods and strategies for teaching the use of technology tools.

5.2.1 demonstrate methods for teaching hypermedia develop-ment, scripting, and/or computer programming in a problem solving context in K-12 schools.
5.2.2 demonstrate methods for teaching at least one modern authoring tool to colleagues and students.
5.2.3 demonstrate methods for teaching uses of media-based tools such as television, audio, print media, and graphics.
5.2.4 demonstrate methods for teaching social, ethical, and legal issues and responsible use of technology.

5.3 Staff development.

Candidates will demonstrate knowledge of issues and models related to leadership in staff development. Candidates will plan and design staff development activities for educational settings.

5.3.1 plan and design staff development programs.
5.3.2 describe and identify resources for staff development.
5.3.3 plan and customize staff development based on differing audiences including school and district decision-makers.

5.4 Facilities and Resource Management.

Candidates will demonstrate knowledge of issues related to facilities and resource management.

5.4.1 describe and use budget planning and management procedures related to educational computing and technology facilities and resources.
5.4.2 identify funding sources available at local, state, and/or national level and collaborate on development of a grant proposal.
5.4.3 plan, develop, implement and evaluate strategies and procedures for resource acquisition and management of technology-based systems including hardware and software.
5.4.4 identify, describe, and analyze procedures related to basic trouble shooting, preventive maintenance, and procurement of system wide maintenance services.
5.4.5 describe and maintain current information involving facilities planning issues related to computers and related technologies.

5.4.6 design and develop policies and procedures concerning staffing, scheduling, and security for managing computers/technology in a variety of instructional and administrative school settings.

5.5 Managing the Change Process.

Candidate will demonstrate knowledge of strategies for and issues related to managing the change process in schools.

5.5.1 evaluate school and district technology plans recommend improvements.
5.5.2 discuss issues relating to building collaborations, alliances, and partnerships involving educational technology initiatives.
5.5.3 demonstrate knowledge of effective group process skills.
5.5.4 use evaluation findings to recommend modifications in technology implementations.

5.6 Field Experiences.

Candidates will participate in field experiences that allow them to (1) observe the use of technology to support instruction, the management of technology resources in educational settings, and the evaluation of effectiveness of technology resources for teaching and learning; and (2) apply technology resources to support instruction in classroom settings.

5.6.1 observe and compare methods and strategies used in educational technology in a variety of authentic educational settings (i.e., elementary, middle, secondary, adaptive assistive classrooms, labs).
5.6.2 develop and teach a series of lessons that apply technology resources to support instruction.
5.6.3 document and assess a significant field-based activity involving experiences in instructional program development, staff development, facilities and resource management, or managing change related to technology use in schools.
5.6.4 document and assess experiences in implementing a WAN or LAN with Internet connectivity.

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Cathy Miles Grant

Professional Development in a Technological Age: New Definitions, Old Challenges, New Resources

INTRODUCTION

WITH SCHOOLS INCREASINGLY INVESTING IN TECHNOLOGIES for the classroom, there has been a growing realization that these expensive resources will never be used to their fullest unless teachers are provided professional development to guide their use. Many schools systems have approached this challenge in the same way that they have approached other learning needs of teachers: by sending them to training sessions on the use of specific new technologies. Yet, too often the results of these sessions have fallen short of hopes: there has been little carryover into the classroom, and new technologies have remained on the periphery of school life and been used only sporadically by teachers, despite the high expectations of trainers, reformers, and the teachers themselves.

Why is this problem so pervasive? This paper looks broadly at the field of professional development and the underlying principles that guide current approaches. We suggest that professional development for technology use creates conditions that highlight and underscore current problems in professional development in general. The paper offers a definition of professional development that goes beyond the term "training" with its implications of learning skills, and encompasses a definition that includes formal and informal means of helping teachers not only learn new skills, but also develop new insights into pedagogy and their own practice, and explore new or advanced understandings of content and resources. Our definition of professional development includes support for teachers as they encounter the challenges that come with putting into practice their evolving understandings about the use of technology to support inquiry-based learning. We suggest specific issues that come with the process of supporting teachers in technology use, and conclude with a discussion of ways that current technologies offer resources to meet these challenges and provide teachers with a cluster of supports that help them continue to grow in their professional skills, understandings, and interests.

BEYOND THE PREVALENT TRAINING PARADIGM

There is an extensive and diverse literature on professional development. Much of the early literature focuses on methods of staff development that follow a "training" paradigm: short-term, standardized sessions designed to impart discrete skills and techniques. Under the right conditions, such as some workshop settings, training-based staff development approaches can be useful in delivering to teachers certain types of information about teaching techniques, for example, methods for organizing portfolio assessment of students' work (Little, 1993) or technology use (e.g., placement of computers in the classroom to support collaborative student work, "learning the ropes" of a telecommunications software package, learning how to connect with the Internet).

Unfortunately, in too many settings this approach has become the dominant or even the only channel for professional development, much beyond the domains in which it can be effective. How can "activities planned and developed far from the school site, with insufficient relevance to ... classroom practices and inadequate follow-up to permit integration of new ideas and methods into professional activities" (McLaughlin, 1991, p. 62) deal with the many broader dimensions of substantive school reform? Professional development must be constructed in such ways as to "deepen the discussion, open up the debates, and enrich the array of possibilities for action" (Little, 1993, p. 148). It must help teachers move beyond "mechanical use" of curriculum and technology to become facilitators of inquiry (Lieberman & Miller, 1990; Little, 1993).

In contrast to the training paradigm, an approach that emphasizes growth and practice holds a view of teachers as professionals who are productive, responsible members of a professional community and who hold a distinct knowledge base from which they act on behalf of their students (Little, 1993). Where often teachers

are labeled as unnecessarily resistant to change, in reality what they are doing is assessing it "for its genuine possibilities and technical adequacy, not to mention how it bears on self and group interests" (Fullan & Miles, 1993, p. 9).

Reflecting this view, more recent professional development programs encourage the "establishment of new norms of collegiality, experimentation, and risk-takingSby promoting open discussion of issues, shared understandings, and a common vocabulary" (Lieberman & Miller, 1990, p. 1049). They emphasize the need to develop new professional cultures in schools (Little, 1981, in Lieberman & Miller, 1990), with structures which enable teachers "to collaborate with colleagues and participate in their own renewal and the renewal of their schools" (Lieberman & Miller, 1990, p. 1051).

As we consider the role of professional development in supporting introduction of technologies in schools, this paper builds upon a growing understanding that effective programs in professional development are inextricably linked to building a professional culture in schools, one which supports qualities of reflection and collaboration in the context of action. We consider the following topics:

1. Underlying principles that serve as foundations for successful practices in professional development to support the introduction of technologies in schools

2. Supports required for teachers to use technology effectively

3. Professional development approaches that can introduce and support collegial, ongoing, and informal contexts for teacher learning overall and engagement with technology in particular

4. Ways technologies can support the process of professional development for teachers

5. Putting the pieces together: two case studies of integrative approaches to professional development.

Because school improvement is a systemic process (Fullan & Miles, 1993), and professional development both changes and is changed by the organizational context in which it takes place (Sparks & Loucks-Horsley, 1990), we recognize the importance of a comprehensive approach that includes professional development for principals, assistant principals, and administrative and resource staff at school and district levels. However, this paper focuses on professional development for teachers because of their central role as those who plan, guide, and direct the daily activities in the classroom and who must find ways to assure that technologies are used most effectively to support student learning.

Furthermore, we understand technology to be a powerful tool to support inquiry-based learning in schools: learning that is constructivist in orientation, that values conceptual understanding over procedural efficiency, that is responsive to students' prior knowledge and experience, that builds connections to the world outside schools, that supports the development of metacognitive skills, that prepares for lifelong learning, and that promotes educational equity (see Rubin, p. 34). We recognize that these important understandings about technology's role in supporting student learning are equally critical to understanding its role in enhancing teachers' learning. To create inquiry-based environments for their students, teachers themselves need experience with learning in inquiry-based environments. Only then can they internalize its aims and transform the ways in which they teach their students.

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The diagram in Figure 1 depicts increasing levels of professional use along the vertical axis, and increasing levels of SC&LK along the horizontal axis. The band along the 45-degree part of the diagram depicts educators who are making professional use of the technology at a level consistent with their levels of SC&LK. The small dots outside of this band depict outliers--educators whose use levels are quite a bit higher or lower than their levels of SC&LK.

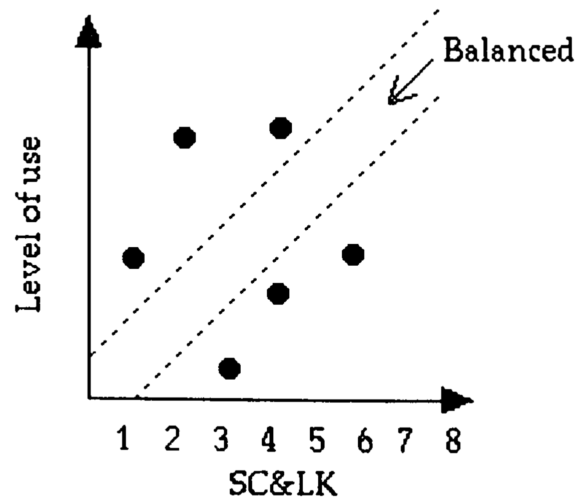

Figure 1. Graph of use levels versus Concerns & Knowledge levels.

Professional development can be aimed at moving educators both toward higher SC&LK levels and toward a higher level of use. Several ways to do this include:

1. Provide a supportive and personal approach. One-on-one help is particularly important. Some of this can occur in the teacher's classroom, with the facilitator taking over the class and demonstrating the desired levels of activities and then facilitating the teacher to function in this classroom role. In other cases--for example, helping a teacher learn to use an electronic gradebook or surf the Internet--individual help outside of the classroom setting is very effective.

2. Using the school's technology resources in a manner that supports risk taking on the part of teachers. Have a system in place that provides immediate support to a teacher who runs into hardware or software difficulty while using a computer in the classroom. Develop a school leadership structure that encourages and rewards risk taking.

3. Provide special training to some students to serve as classroom assistants for information technologies. Some of the burden of helping students learn to make classroom use of these technologies is then transferred to these students.

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A Rising Tide of Expectation

The SC&LK model does not specifically address the rising tide of expectation that is accompanying the field of information technology in education. Each year, the standards are going up. Each year, the average level of information-technology knowledge of students in increasing. Each year, more information technologies are being integrated into the guidelines, benchmarks, and standards that help drive curriculum, instruction, and assessment.

This rising tide of expectation means that every educator needs to be involved in ongoing professional development in the information technologies. In just a few years, a person who was an early adopter and a school leader can fall behind unless engaged in ongoing professional development.

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An Effective Inservice Model

This section outlines a model for working with small to large groups. It is research-based model for staff development for technology in education that has been shown to be quite effective (Moursund, 1989). The inservice might be targeted toward a number of teachers from different schools in the school district. For example, it might be specifically designed for high school social studies teachers or for middle school math teachers. Alternatively, in a specific school an inservice might be targeted at all teachers who are at levels 1 or 2 on the SC&LK scale. As indicated earlier in this report, this same model for group inservice has proven effective in working with a combination of teachers and students.

1. Do a needs assessment. Many schools and school districts have developed a long-range plan for computer use and a more general long-range plan for their schools. These plans provides a good starting point for a needs assessment. The overarching goal of the inservice is to facilitate classroom implementation of goals specified in the existing plans of the school and district.

2. Plan carefully. Design the inservice and make the necessary arrangements for facilities. Give careful consideration to holding some or all of the sessions in the participants' schools. Make sure that the planning process includes the participants and that the plan actually meets their needs.

3. Recruit participants. Keep in mind the desirability of having a critical mass of participants from each participating school and of having administrative support and participation. By and large, it is easier to work with participants who have relatively homogeneous computer backgrounds and teaching interests. Job-alike groupings can be especially effective.

Cycle through steps 1-3 as needed. For example, information obtained during the recruiting process may contribute to the needs assessment and lead to changes in the plans. Some participants will have considerably more experience than others in technology and in classroom implementation. Consider how these more knowledgeable educators will be facilitated and used in the inservice. They want to learn, but at the same time they can be a valuable resource for others.

4. Do extensive advance preparation. Carefully and fully prepare the content of the inservice series. Prepare handout materials. Make sure that the handout materials include good examples that the teachers can immediately use in their teaching. As a rough rule of thumb, the first time a person facilitates a particular inservice they will probably need to spend at least 10 hours of preparation time for each hour of inservice.

5. Check out the inservice facilities. Pay particular attention to the hardware, software, networking and connectivity, and room lighting. Is the lighting appropriate for use of projection equipment? Make sure you arrive at the inservice site early enough to recheck all of the facilities to make sure they are working well.

6. Do an inservice session. Be aware that teachers like inservices to have a substantial hands-on component. (In general, from the participant point of view, the more hands-on time, the better.) Conducting a hands-on inservice for a group of educators is very challenging to the facilitator. Having participants work in teams of two tends to reduce pressures on the facilitator. Even then, very few inservice providers can effectively handle a group of more than 15-20 educators in a hands-on session. For larger groups, assistance is essential.

7. Focus on classroom implementation. Each inservice session should have a major emphasis on preparing participants to immediately make use of their new knowledge and skills. There should be an expectation that teachers will begin classroom implementation immediately.

8. Evaluate. Conduct informal and formal formative evaluation as seems appropriate. For example, have participants fill out an evaluation form at the end of each session. The form should encourage participants to provide suggestions on ways to make the inservice better fit their specific needs.

Repeat steps 5-8 for each session in a series. Provide time in each session for doing any necessary follow-up support for the preceding session.

9. Do a summative evaluation at the end of the inservice series. From the point of view of the participants, what went well and what didn't? What could be improved, and what changes in emphasis would make the inservice series more valuable to participants? Were the design, implementation, and outcomes sufficiently successful so that the inservice should be repeated for other groups of teachers? (See the section on evaluation later in this document.

10. Continue to provide follow-up support to the participants after the inservice series ends. This might involve a combination of support from the inservice staff and the participants providing support to one another.

11. Evaluate the long-term residual impact. Gather data on the effects of the training six months to a year after the inservice series ends. Are the participants exhibiting the behaviors that the inservice was designed to promote? Look for ways to improve the design of the inservice so that the next time it is given, it will have a greater long-term impact.

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Ineffective Inservice

Many large-group inservices contain one or more of the following flaws:

1. The inservice is based on *inadequate needs assessment,* not firmly rooted in long-range technology planning. The inservice is not designed to address the participants' SC&LK levels. The inservice violates the basic research knowledge about adult education, with little or

no focus on the specific needs of the participants.

2. *A "one-shot" approach* is used, and there is little or no follow-up support. Research suggests that one-shot inservices are rarely effective. Change literature suggests that educational change takes a long time and substantial effort. Training may need to be spread out over period of years.

3. The inservice *focuses only on a particular computer tool.* Little or no time is provided to study needed changes in the curriculum, to learn to deal with new classroom organization and management situations, to develop and critique lesson plans, and so forth. The inservice focus tends to be on the "key presses" and details of using a particular piece of software rather than on the underlying theory and higher-order thinking and problem-solving skills.

4. The inservice *focuses on single individuals* (one person per school or per district) rather than concentrating on reaching a critical mass of teachers in a single school. It is essential to define the unit of change (large department, a grade level, a school) and have a critical mass of inservice participants from that unit. The collegiality of a substantial support group contributes substantially to the successful implementation of what one learns in an inservice.

5. Most computer technology inservices have *unrealistic expectations for outcomes.* A high school math teacher might be taught how to use electronic spreadsheets to present and solve a variety of math problems. However, the computer lab is at the other end of the teacher's building and is heavily scheduled for computer literacy classes. Furthermore, the school's mathematics instruction is dominated by state-mandated standardized tests, which don't account for (or even allow) computer use. In this situation, the inservice can probably have little effect on instruction or the desired student achievement.

6.*Handout materials are inadequate.* The actual inservice time is quite short. Inservice participants are expected to apply what they learn and continue learning on their own. Handout materials should help make maximum use of the inservice time, include sample lesson plans or other aids to application, and direct participants to additional resources for independent learning.

7. *There is little direct support from administration at the school or district level.* Research strongly supports the contention that little classroom change is apt to occur without such explicit support. It is highly desirable for school administrators to participate in the inservice alongside their teachers.

8. *There are few incentives for teachers to make substantial changes* in their curriculum. Effective instructional computer use generally requires substantial changes in both the content and conduct of the curriculum.

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Evaluation of Inservices

Inservices can be evaluated at four levels of outcomes:

Level I: Implementation of the inservice program. This measures the quality of the training itself. The focus is on the preparation

of the facilitator and the quality of the inservice. Inservice participants are typically asked to fill out an evaluation form at the end of the inservice.

Level II: Teacher improvement. This measures actual classroom behavior change in the participating teachers. How well are they implementing the knowledge and skills addressed in the inservice? The inservice participants can be asked to self-evaluate their implementation progress. They can visit each other's classrooms to observe and comment on progress, or the inservice provider or another outside evaluator can visit their classrooms.

Level III: Change in student performance. This measures the degree to which improvements in teacher performance lead to improvements in student achievement. Are students learning to make effective use of information technologies? This requires pre-and post-inservice gathering, followed by careful analysis. Data can be both quantitative and qualitative. Although this type of evaluation is typically done by a professional evaluator, it can be done by the inservice participants as a type of action research.

Level IV: Changes in the environment. This measures changes in the school that may be indirect--or even unintended--results of the inservice program. Are there systemic changes that support permanent implementation of the new classroom curriculum, instruction, and assessment?

The goals of professional development in a school or school district should be at Level III and Level IV. However, most professional-development programs are evaluated at Level I. Only a small percentage are evaluated at Level III, and almost none are evaluated at Level IV. Thus, we gain little information about whether the professional development is really making a significant difference.

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Final Remarks

Every school needs an ongoing program of professional development for information technology use in education. This program needs to be geared to the specific implementation levels as well as the Stages of Concern and Levels of Knowledge of the educators.

An effective model for such a program has three major components. One component is "traditional" group inservice, with large numbers of participants who are exposed to essentially the same materials. For example, this might be appropriate if a school has made major changes in its computer facilities during the summer, such as installing an Internet connection into every classroom, or making an initial acquisition of CD-ROM references for the library.

A second component is one-on-one staff development making use of a peer-support model. Each teacher has the responsibility of being both a learner and a facilitator of peer learning.

A third component is teachers learning alongside and from their students. Teachers and students learn together, all working to meet high educational standards in their school.

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References

Fullan, M. G. (1991). *The new meaning of educational change.* New York: Teachers College Press. A definitive work on educational change, with a major emphasis on projects designed to produce such change.

Hall, G.E. (1974). *The concerns-based adoption model: A developmental conceptualization of the adoption process within educational institutions.* . Austin, TX: Research and Development Center for Teacher Education. Presents and analyzes "stages of concern" as an approach to meeting the staff development needs of educators.

International Society for Technology in Education. (1993). *Curriculum guidelines for accreditation of educational computing and technology programs.* Eugene, OR: Author.A detailed report on the National Council for Accreditation of Teacher Education (NCATE) standards for teacher preparation in the area of computer technology in education. An updated list of these guidelines (approved by NCATE in 1996) can be found on the World Wide Web at www.iste.org.

Joyce, B. and Showers, B. (1988). *Student achievement through staff development.* New York: Longman. An overview of models of staff development with special emphasis on a coaching model that is designed to personalize staff development within a school building.

Moursund, D. (1989). *Effective inservice for integrating computer-as-tool into the curriculum.* Eugene, OR: ISTE. Summarizes the research literature on effective inservice for computer technology in education. Includes a variety of forms for the evaluation of an inservice.

Moursund, D. (1995). *Increasing your expertise as a problem solver: Some roles of computers.* Eugene, OR: ISTE.An introduction to the theory and practice of getting better at solving problems, with special emphasis on the roles of computers.

Moursund, D., Bielefeldt, T.; Ricketts, R.; and Underwood, S. (1995). *Effective practice: Computer technology in education.* Eugene, OR: ISTE. A comprehensive summary and analysis of the research literature and other information on effective uses of computer technology in K-12 education.

National Commission on Teaching and America's Future (1996). *What matters most: Teaching for America's future.* New York: Author. An extensive report by a Blue Ribbon committee addressing strengths and weaknesses of the preservice and inservice preparation of teachers. The emphasis is on what needs to be done to have better teachers--and hence, better education for students.

National Foundation for the Improvement of Education (1996). *Teachers take charge of their learning: Transforming professional development for student success.* Washington, DC: Author. A careful study of professional development that emphasizes its roles both in empowering teachers and in improving education for students. Includes an extensive bibliography.

National Staff Development Council (NSDC). PO Box 240, Oxford, OH 45056; 800/727-7288; Fax 513/523-0638; NSDCHavens@aol.com. The NSDC is a professional society supporting the work of staff developers in all subject areas.

Negroponte , N. (1995). *Being digital.* New York: Knopf. A collection of short essays that explore the state of the art of computer technology from a multimedia point of view. Negroponte discusses how the ability to store, manipulate, and transmit "bits" of information (the hallmark of the Information and Communications Age) is changing the world.

U.S. Congress, Office of Technology Assessment. (1995). Teachers and technology: Making the connection (OTA-EHR-616). Washington, DC: U.S. Government Printing Office. A comprehensive study of technology in U.S. schools. Provides good insight into the current status and possible futures of technology in K-12 education.

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PRINCIPLES FOR SUCCESSFUL PRACTICES IN PROFESSIONAL DEVELOPMENT

Extending a Vision of Technology as an Empowering Tool

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Providing Continual Contexts for Formal and Informal Learning

Providing Opportunities for Meaningful Leadership Roles to Emerge

Enabling Teachers to Shape their Own Learning

Whether or not a new procedure, curriculum, or innovation such as technology integration takes hold depends on "the extent to which the school creates a *professional community* that harnesses and develops individual commitment and talent into a group effort that pushes for learning of high intellectual quality" (Brandt, 1995, p. 73). We believe that the following principles of professional development are central to creating and nurturing such a professional community of teachers working with the complex task of bringing technology into schools to enhance learning:

- Professional development for technology must extend *a vision of technology as an empowering tool for teachers and students.*
- Professional development must stimulate reflective practice and be grounded in the *context of teaching.*
- Professional development must exemplify *our deepest beliefs about learning:* inquiry, collaboration and discourse.
- Professional development must recognize the *interplay in learning between activity and belief.*
- Professional development must value and cultivate a *culture of collegiality.*
- Professional development programs must provide *continual contexts for formal and informal learning.*
- Professional development must provide *opportunities for meaningful teacher leadership roles to emerge.*
- Professional development must enable teachers to *shape their own learning.*

Extending a Vision of Technology as an Empowering Tool

Technology is best seen as a facilitator of learning rather than an end in itself. Many teachers are not motivated by the idea of placing technology in their classrooms. But they are motivated by the vision of helping their students to learn more and take more control of their learning. Technopush does not work. Learning more effective strategies for teaching does. (Mergendoller, 1994, p. 6.20-1)

The goal of professional development for technology should be to help teachers become more productive professionals, and to empower them to make sense of how mastery of technologies can be useful to them, in their teaching and as a tool for professional growth. What teachers learn about technology should be personally valuable for the things they need to do. And learning about technology should be exciting and exhilarating. As one teacher suggests, "We want to help make teachers fearless with technology" (Office of Technology Assessment, 1995).

What, then, do teachers need from a professional development program to support technology use in schools? They need to become comfortable enough with technologies to grasp their potential for teaching and learning, to navigate changes in practice and pedagogy to meet that potential, to evaluate and make choices among myriad options, and to manage the enormous quantities of information that come their way as a result of increased access to primary sources and to a much more extensive audience. They need to position themselves to become continual learners, from one another, from their students, and from the broader world "out there." Most important, they need to make technology tools their own.

Many school technology programs emphasize teacher mastery of operational skills; i.e., how to make technology work (OTA, 1995). Though important, mere proficiency cannot be the central goal of a technology professional development program. Teachers must be involved in defining an educational vision from which decisions about technology use will be made. Rather than concentrating solely on technology, professional development should promote significant school talk about ideas and issues that technology can facilitate (Lieberman & Miller, 1990).

In *Teachers and Technology: Making the Connection* (OTA, 1995), a national study for the U.S. Congress, teachers identified the key areas, beyond operational skills, they need in order to make effective use of computers in their classrooms:

- A broader understanding of what the technologies can do (ways in which it can enrich and support the ongoing work and goals of their own classroom)
- Provision for the time and effort that are required for educating themselves about a particular piece of hardware or software, and its applications for their classroom
- Knowledge about how to organize and effectively manage their students in technology-based environments
- Knowledge about how to teach with technology or to orchestrate learning activities in order to make optimal use of it.

Professional development programs also need to help teachers integrate technology into their ongoing practice. Teaching to support inquiry with technology requires, among other things, that the teacher become a facilitator of student explorations, a fellow problem solver, and a resource for integrating students' diverse experiences, knowledge bases, and understandings. Teachers need support in developing alternative structures and approaches to the traditional methods in which the teacher's primary role has been that of deliverer of knowledge.

Stimulating Reflective Practice That Is Grounded in the Teaching Context

> [T]he most promising forms of professional development engage teachers in the pursuit of genuine questions, problems, and curiosities, over time, in ways that leave a mark on perspectives, policy, and practice. (Little, 1993, p. 133)

The realities of teaching, and the experience of teachers, must provide the backdrop onto which new ideas are considered and reflected upon. Powerful teaching is a deeply intellectual activity, involving asking questions, observing carefully, making connections between discrete experiences, developing approaches and solutions based on needs of one's students and classroom, and reflecting on practice.

In *The Reflective Practitioner*, Schön (1983) describes reflection-in-action as the conscious interaction by the practitioner with a problematic situation, and the conversation and experimentation that accompanies it.

Grimmet et al. (1990, p. 23) describes one aspect of reflection as "a process that leads to thoughtful, mediated action." Through the habit of reflection we make sense of experiences. We attend to features of a situation that we had previously ignored, and assign new significance to previously identified features. "Reflection involves recasting situations once they have been clarified, rethinking the assumptions on which initial understandings of a problematic issue were based, and beginning to reconsider the range of possible responses [one] might use" (p. 27).

As part of their reflective practice, teachers need to look beyond the segmented boxes of curriculum, subject areas and the demands of day-to-day practice. To tap their students' personal knowledge and to better understand their interaction patterns, teachers need to reach further than the context of the classroom and seek to comprehend the range of personal and cultural experiences that students bring to learning (Valli, 1990). And teachers need to look at the wider meanings and purposes of school work, and at the connections between students' experiences, teachers' classroom practice, and schoolwide structures and cultures (Little, 1993).

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Exemplifying Our Beliefs on Learning: Inquiry, Collaboration, and Discourse

> Compared with the complexity, subtlety, and uncertainties of the classroom, professional development is often a remarkably low - intensity enterprise. It requires little in the way of intellectual struggle or emotional engagement and takes only superficial account of teachers' histories or circumstances. Compared with the complexity and ambiguity of the most ambitious reforms, professional development is too often substantively weak and politically marginal. (Little, 1993, p. 148)

Professional development should offer "meaningful intellectual, social, and emotional engagement with ideas, with materials, and with colleagues both in and out of teaching" (Little, 1993, p. 138). Because the reform movement in education is based on a view that children need to construct their own understanding of the world through active engagement with topics and problems that are meaningful to them, it is logical that constructivist staff development is, therefore, the best way to support constructivist learning (Sparks, 1994). Teachers need the opportunity to construct their own knowledge through interaction with others about meaningful activity; they need permission to experiment and take risks; and they need to do their learning in an environment that is respectful and supportive.

The pursuit of knowledge, through continuing inquiry and experimentation, is central to professional development (Little, 1993). Rather than handing "development" to teachers, those interested in supporting the professional growth of teachers need to encourage them to identify and "formulate valid questions about their own practice, and to pursue objective answers to those questions" (Sparks & Loucks - Horsley, 1990, p. 243). They should invite - and, with the support of technology, enable - teachers to theorize, interpret, and critique their own practice (Cochran - Smith & Lytle, 1993). Rather than promoting the consumption of knowledge, professional development should support the process of teachers generating their own knowledge and *assessing* that claimed by others (Little, 1993).

Teachers need to be supported in developing the ability to respond thoughtfully to the ambiguities and changes that reform presents, as well as the day - to - day challenges of the practice. How can technologies support and enhance core learning experiences in the classroom? How can effective use be made of authentic assessments to better understand student learning? How can teaching accommodate diversity in culture, language, socioeconomic role, gender, and learning style? These and many other pressing questions are central to teaching and learning in schools today, and provide teachers with opportunities to contemplate, articulate, and elucidate their own deepest beliefs and understandings about learning.

Teachers also need to have the opportunity to actively expand and shape their understanding of the content that they teach.

> Teachers are also learners - learners of practice. If we are to support their efforts to teach science well, we need to provide forums in which they can do science in new ways, reflect on their own learning and consider implications for their own classrooms. If current theory is to reach the classroom, teachers must have more than awareness of current ideas. They must have action knowledge that can only come from experiencing active learning themselves. (Doubler et al., 1994, p. 3)

Whatever the subject domain, by becoming active learners themselves, teachers can deepen their understanding of the content that they teach, and the processes by which their students learn. Through the process of conducting their own inquiries, they learn what it is to become deeply engaged with the content that they teach. Through collaboration, they come to value the contributions of various team members to the evolution of the group's thinking. And through collegial interchanges and study they come to recognize the importance of

discourse in sense - making, and to value their own central role as listeners and fellow sense - makers, as well as teachers (Warren & Rosebery, 1992).

When viewed as providing lifelong learning opportunities for teachers, professional development can promote a spirit of inquiry into teaching, learning, and the vast fields of knowledge and understanding.

Recognizing the Interplay in Learning Between Activity and Belief

Belief and practice are very closely linked. Some learners prefer starting from the conceptual and then moving into experience. Others prefer beginning with practice and then addressing beliefs. Whatever the case, it is important for professional development programs to provide opportunities for both.

As they grow professionally, teachers need frequent opportunities to play activity and belief off one another. No matter how compelling a vision is, one can only go so far down a path through intellectual reasoning alone. Experience gives new meaning to theory and sparks new understandings. At the same time, the periodic opportunity to step back from practice and to grapple with its meaning and direction is essential to making new ideas and approaches one's own.

Some of the most important changes in teacher attitudes and beliefs come after they have implemented changes and seen evidence of improved student learning (Guskey, 1986, in Loucks - Horsley et al., 1987). Only after they have mastered the basic elements of implementation of a new idea are teachers ready to grapple with the underlying meanings of innovations and how they are reflected in actual experience (Loucks - Horsley et al., 1987).

Valuing and Cultivating a Culture of Collegiality

> When teachers work together to develop common bonds around shared goals, interactive decision making, and mutual inquiry, there develops a school culture that is rewarding for teachers as well as beneficial for students. When teachers are engaged together in thinking aloud about their work and its consequences, the results are not simply a greater sense of professionalism on the part of teachers, although that certainly is the case, but a stronger and more coherent instructional program for children and youth. (Griffin, 1991, p. 250)

"[R]ecent research points strongly to the power of teacher - teacher professional collegiality as a key to school success and to effective school change" (Lieberman, 1986). Personal reflection feeds and is enriched by a learning community. In schools enriched by a professional culture of collegiality one recognizes the important role of informal networks in providing means for intellectual learning and social support for teachers (Lieberman & Miller, 1991). In such a culture, teachers talk to one another about teaching often "at a level of detail that makes their exchange both theoretically rich and practically meaningful"; they work with colleagues to plan, prepare, and evaluate teaching topics, methods, and materials (Little, 1987, p. 503); they make fruitful use of observations in each other's classrooms; they train together and train one another; they form "long - term habits of shared work and shared problem solving" (Little, in Lieberman, 1986, p. 43); and they provide one another with collective support. Lieberman and Miller cite a study in six urban schools in which norms of collegiality and experimentation were established:

> As teachers and administrators talked together about their work, observed one another, and involved themselves in problem - solving activities, they came to "own" issues in common, consider alternative approaches, and value one another as people engaged in a common enterprise. (Lieberman & Miller, 1991, p. 105)

Providing Continual Contexts for Formal and Informal Learning

Professional development should not be a process of "inoculating" teachers with a given set of in - service development activities. Rather than a one - shot injection of information, professional development needs to be seen as a continuing process that values, builds upon and supports the learning of teachers, via informal and flexible means as well as through more formal professional development activities.

The teaching population embodies a range of experience, expertise, and settings (Little, 1993). A successful teacher development program is characterized by diversity of ideas, people, and support practices, in response to the uniqueness of concerns, interests, and cultures within the school building and staff (Loucks - Horsley et al., 1987, p. 21).

A successful program of professional development also incorporates an understanding that change is a process: that it is a collection of individuals who take part in that process: that change is a highly personal experience, to which each individual reacts differently; that those individuals have preferred modes of learning; and that change involves developmental growth (Hall & Hord, 1987).

> There is a personal side to change that is frequently ignoredS [W]e believe that, for change to be successful, the perceptions of the clients (e.g., teachers) must be understood by themselves and by the change facilitators. Without understanding where the clients "are," only through chance will the interventions made by change facilitators address the needs of innovation users and nonusers. (Hall & Hord, 1987, p. 8)

As individuals grow in their knowledge about innovations and as their practice changes, they experience different types of concerns. The Concern - Based Adoption Model (Hall & Hord, 1987) provides a lens through which to look at ways in which individual teachers experience innovations, and what kinds of support might assist them most appropriately. For example, when they are first introduced to a new practice, for many teachers the dominant concerns are personal: "What is it, and how will it affect me?" Later, their concerns might center around mastery of the new practice, and how to coordinate and organize it more comfortably into classroom routines. Finally, as they become more comfortable with the practice, teachers' primary concerns might focus on how it is affecting students, and how it might be adapted to have more of an impact on particular goals (Hall & Hord, 1987).

To support any reform effort, it is essential that teachers at all levels of experience and sophistication be provided with entry points into the learning process (St. John et al., 1994). These entry points may be different for different people, depending on what they know and need. This might mean introductory workshops and technical assistance to those who are new to technology and hands - on learning; long - term support for teachers who are just beginning to implement these processes in their classrooms; long - term professional development for teacher leaders who provide professional support for their colleagues; and opportunities for leaders of the reform effort to engage with others doing similar work as they continue to hone their skills and deepen their understanding of their own work (St. John, 1994, p. III - 8).

Providing Opportunities for Meaningful Leadership Roles to Emerge

> True teacher leadership enables practicing teachers to reform their work and alter the hierarchical nature of schools. (Boles & Troen, 1995, p. 30)

One of the challenges that schools face is the double demand of improving the quality of students' educational experience while simultaneously working to retain, stretch and nurture top - quality people in the teaching profession (Wasley, 1991b). Providing opportunities for teachers to take on leadership roles holds promise for tapping the talents of gifted teachers as they grow. Developing leadership requires establishing a culture in which roles are interchangeable and where it is not always clear who the "experts" are.

When schools offer teachers the possibility of taking on leadership responsibilities, these teacher leaders can develop a whole new set of skills as they seek to influence their colleagues (Wasley, 1991a). And where structures are in place to support their work, teacher leaders have reported finding both extrinsic rewards (lighter teaching loads, release time, extra stipends) and intrinsic rewards (personal satisfaction, resume building, greater influence) in taking on these roles (Wasley, 1991b).

Teacher leaders need to have knowledge that is specialized and accessible if it is to be useful to their colleagues seeking to incorporate new approaches and tools into their teaching (Griffin, 1991). Supportive structures need to be in place in order to facilitate good communication between teacher leaders, administrators, and other teachers. And as they work to define their roles in schools, teacher leaders need to model reflective practice themselves as they explore how their position can best support the growth of students as well as other teachers in the school (Wasley, 1991b).

Enabling Teachers to Shape their Own Learning

> [I]ndividuals can best judge their own learning needs and...they are capable of self direction and self - initiated learning. [Individually guided professional development]...assumes that adults learn most efficiently when they initiate and plan their learning activities rather than spending their time in activities that are less relevant than those they would design. (Sparks & Loucks - Horsley, 1990, p. 42)

If, as we believe, professional development is at the heart of school change, then thinking and planning for professional development must be grounded in a deep understanding of both the possibilities and the constraints of school life. It must be guided by respect for teachers' own qualities of reflection, flexibility and vision. It must recognize that at any point in time teachers are at different places with reference to experience and expertise. And it must address the issue of teacher authority - teacher authority, as in teachers as authors of their learning trajectory as they plan for and carry out activities that they think will advance their own learning (Sparks & Loucks - Horsley, 1990).

The job of professional development is to support teacher engagement and reflection around new initiatives and areas of growth teachers themselves are seeking, in the delicate balance of top - down/bottom - up efforts that builds and sustains vital school communities.

> A supportive context for staff development requires both a top - down and a bottom - up approach. The top - down component sets general directions for the district or school and communicates expectations regarding performance. The bottom - up processes involve teachers in establishing and designing appropriate staff - development activities. (Lieberman & Miller, 1986, p. 246, in Sparks & Loucks - Horsley, 1990)

Each of the underlying principles noted in the above section are foundations for a professional development program that successfully builds on an understanding of enhancing lasting teacher growth. These principles apply, and are perhaps even more important, to enabling teachers to grow and learn with technology.

Furthermore, as the next section makes clear, just as careful thought needs to be given to underlying principles that make up a successful program of professional development, thorough planning needs to go into providing the necessary supports for enabling teachers to use technology effectively.

SUPPORTS REQUIRED FOR TEACHERS TO USE TECHNOLOGY EFFECTIVELY

> It is virtually impossible to create and sustain over time conditions for productive learning for students when they do not exist for teachers. (Sarason, 1995)

Technology use creates a special set of conditions that present challenges for successful professional development, challenges that tend to make the terms "professional development" and "support" analogous. The technical, pedagogical, and rapidly evolving characteristics of technologies for education create a particular need for professional development models that are built around an expansive definition of support. McConachie discusses the importance of community support (see p. 119). In its recommendations to the U.S. Congress, the Office of Technology Assessment (1995) suggested that schools and districts should devote at least one third of the resources of technology budgets for teacher training and support. Key components of necessary support for professional development with technology include the following:

- Access to Equipment
- Technical and Pedagogical Assistance: Ongoing, On-Site and Job-Embedded
- Administrative and Community Backing
- Time for Learning and Collaborating
- Sustainability: The Long Haul of Change

Access to Equipment

As professionals working in an information age, teachers need to develop facility with a range of technology tools. These tools can play a powerful role in helping teachers enhance instruction, simplify administrative tasks, and improve communication to foster professional growth. Yet "there is no single best technological medium that suits all teachers equally well," and "there does not appear to be one best way for teachers to implement technology" (OTA, 1995, p. 57). Teachers need support in learning the range of resources that are available to them; they need to decide what makes sense for their own use; and they need access to equipment in order to become proficient with the medium of their choice.

Teachers' mastery is dependent on their having extensive hands-on time with the tools they are learning to use. They must have ready access to appropriate technology if they are to build on training experiences by experimenting with tools and approaches on their own time. Although it can seem expensive to provide each teacher with a computer, a modem, and connections, having technology on hand is essential if anything learned in an initial learning experience is to "stick." In addition, as discussed later this paper, these are the very tools that can expand the options beyond the training/workshop model of professional development on which many schools rely entirely.

an effort to support teachers' learning of technology, some schools and districts are giving all teachers a ɪmputer. The hope is that, as they become proficient with applying computers and related technologies for their own personal and professional uses, teachers will be encouraged to experiment with using technologies

with their students (OTA. 1995):

> While some training is still important in this strategy, the real learning is believed to come from giving teachers unlimited access to the technology (and potentially more time on the equipment), new motivation for learning to use it. and a community of peers who are trying to master the same tools." (p. 152)

> The Indiana Department of Education sponsors an innovative program called A Computer for Every Teacher (CET). A computer and printer are provided to every teacher in the school. for use at home or in school. as they see fit. Training focuses on basic computer functions and software selected by the school and includes basic elements of word processing, graphics. spreadsheets, databases. and gradebooks. An important component of the program has been the participation of all professional staff. learning together: teachers. administrators. and support staff. As a result of participation in the program. teachers' productivity has improved. their sense of professionalism has been enhanced. and their individual and institutional esteem has increased (OTA. 1995. p. 152).

Technical and Pedagogical Assistance: On Site and Job Embedded

> Supporting teachers in their efforts to integrate technology throughout their teaching is central if technology is to become a truly effective educational resource, yet true integration is a difficult, time-consuming, and resource-intensive endeavor. (OTA 1995, p. 161)

Professional development activities need to be "situated andSembodied in the teaching context," (McLaughlin, 1991, p. 70) and any initial training experience be followed up with support and coaching. When confronted by the "nowness" of their classrooms, teachers need support as they make attempts at growth and change. In this way teachers move from the group experience to more personalized staff development that is subject and teacher-specific (OTA, 1995; Loucks-Horsley et al., 1987; Mergendoller, 1994; McLaughlin, 1991).

Teachers also need on-site technical support to help them set up, trouble-shoot, and fix the machines. And because "just in time" support with the technology problems that inevitably arise is crucial to the success of a class plan, teachers need to be assured that technical assistance will be provided to them in a thorough and timely way.

Even with the very best planning, though, just in time support from a designated technology specialist will not always be available to teachers. As a long-term strategy for sustaining initiatives in technology use in schools, the base of technical support must be broadened.

There are various ways in which this base of technological expertise can be extended beyond the resources that are provided by the professional development and technological budgets. For example, students who are eager to serve as resident experts can be enlisted to help using models like the student technology service program in place in Olympia, Washington or the recently created American Technology Honor Society (see McConachie, p. 119). External resources can be marshaled using models like the U.S. Tech Corps, in which community members work with individual teachers and classes on new areas of technology, provide in-class support for teachers, help with trouble-shooting, and assess the state of school hardware (see p. 119). A school can develop a "collective resume," a database of technological capabilities, in order to make it easier to draw on the expertise of colleagues, students and community members (Hull Public Schools, MA).

Administrative and Community Understanding and Commitment

> OTA has consistently found that when administrators are informed about and comfortable with technology, they become key players in leading and supporting technology integration activities in their schools. Some technology implementation efforts are building on these lessons by including principals or other key administrative staff in training opportunities offered to teachers. (OTA, 1995, p. 153)

For many teachers, intrinsic rewards drive their efforts to learn about technology and to make changes in their teaching. These rewards can include satisfaction in finding tools that support students' learning and that engage their interest and enthusiasm, meeting new people and working with colleagues, increasing knowledge and competence, reflecting on alternative teaching strategies, developing mastery of new skills, and developing recognition and respect (Loucks-Horsley et al., 1987; OTA, 1995).

Nevertheless, learning about technology takes time and energy. Furthermore, the process of change is a long one. Applying new learnings about tools, pedagogy and content in the classroom involves taking risks, running into dead ends, and making mistakes. Even accomplished teachers encounter frustrations and failures along the way. Data from a 1990 survey by the Center for Technology in Education at Bank Street College of Education suggest that "[five to six years] appears to be the point at which they [teachers] have a well-organized, workable set of practices. With this foundation, they can flexibly make choices about using new applications and about using familiar applications differently" (Sheingold & Hadley, in OTA, 1995, p. 52).

It is imperative, therefore, that administrators, and particularly principals, offer active leadership to support change efforts. This involves giving permission to teachers to do the messy work of exploring and sometimes failing as they work to incorporate new tools, content and approaches into their teaching. It also involves understanding the time constraints that teachers work with, and supporting them in their efforts to develop flexible ways to work within those constraints. It may require releasing teachers from some professional obligations in order to make room for other opportunities and providing appropriate incentives and rewards (...ay increases, pleasant and well-equipped facilities, materials, access to course credit for professional development, and technological and pedagogical assistance). Finally, it requires that administrators share responsibility for supporting professional development with teacher leaders and other members of the teaching staff.

Principals and other administrators need to learn alongside teachers in order to set a tone of community learning. They also need to participate alongside teachers if they are to be knowledgeable about the particular concepts and practices teachers are working on; to recognize progress as teachers work to implement new tools and approaches; and to make appropriate decisions about disbursal of materials, release time, and other assistance (Little, 1986). They need to hold expectations for planning and trying new ways of teaching, while maintaining respect for teachers' professionalism (McLaughlin, 1991). And administrators and principals need to play a leading role in developing community support and understanding of the goals of technology use in schools, so that teachers are working within a wider framework of informed consent. The Rand Change Agent Study highlighted administrators' role in supporting teachers' efforts at change:

> Motivation of district managers was a "signal" to teachers about how seriously to take a project and its goals. Even teachers with initial interest in a project participated only in a pro forma fashion in the face of apparent district indifference. They assumed their efforts would be neither rewarded nor supported in the long run. (McLaughlin, 1991, p. 63)

Administrator support is critical in enlisting community and parental support that gives teachers permission to do things in new ways that may be otherwise unfamiliar to those comfortable in older models of teaching. This is particularly important in developing a shared school and communitywide vision for change with technology. Without this support, it is very difficult for individual teachers to make changes in their teaching that will be sustained over time (see p. 119).

...ie for Learning and Collaborating

Time is a serious problem. Learning takes time and there is simply not enough to be reflective,

> consider different approaches. learn new materials and behaviors. practice them. and reflect on their impact. Teacher learning must be viewed as an integral part of school life-rather than a frivolous extracurricular activity-and time must be allocated for it. (Loucks-Horsley, 1987. pp. 31-32)

In the study *Prisoners of Time*. the National Education Commission on Time and Learning (1994) noted the constraints placed on teacher learning by the widely held conviction that "in front of the class" teaching time is the only valid use of teachers' time. and "the assumption that reading. planning, collaboration with other teachers and professional development are somehow a waste of time" (p. 17). Beyond actual instructional time, it is essential to provide teachers with adequate release time for planning, for collaborative work with colleagues, for access to consultants. for visiting other classes. and for evaluating innovations and new practices. These are critical to sustain and support personal growth and school restructuring goals.

When new technology tools are introduced in schools. substantial investments of time are required for teachers to master them and to develop meaningful contexts for their use. In addition. because of the constantly changing nature of both hardware and software. teachers need time on an ongoing basis in order to keep up with upgrades. "Even accomplished technology-using teachers. who are highly motivated. rated the lack of time as among the most problematic barriers to technology use in schools" (OTA. 1995, p. 131).

Supporting teacher growth takes time and increases costs. but this tradeoff is necessary for professional growth to take hold. Nothing is gained by having time-efficient staff development efforts that produce no significant teacher learning (Loucks-Horsley et al.. 1987).

> The Monterey California Model Technology Schools responded teachers' need for non-instructional time within the school day by developing the concept of "SuperSubs." SuperSubs, classroom teachers on early retirement from the districts, come supplied with technology lessons and resources when they substitute teach in a class. Thus, while classroom teachers are freed from teaching assignments so they can learn about technology and learning by observing in other classrooms or attending training sessions, their students are provided with technology-based learning experiences that save the regular teacher from setting up special lessons for the substitute teachers. SuperSubs make it easier for teachers to leave their classes for short periods, knowing their students are learning in their absence (OTA, 1995).

Sustainability: The Long Haul of Change

> [S]ystems thinkingSrecognizes the complex, interdependent interrelationships among the various parts of the system. When the parts of a system come together they form something that is bigger and more complex than those individual parts. (Sparks, 1994)

Long-standing policy and practice sustain an enormous and continuous impact on daily practice. Because parts of a school system influence one another in ways which can help or hinder efforts to bring about change, it is important for professional development to take place within the configuration of systemic reform. The interrelationship between different parts of the system, and the ways in which even small changes can have significant effects on other parts of the system (either positively or negatively), must be recognized (Fullan & Miles, 1993; Sparks, 1994).

> Observers remind us of the sheer difficulty of the reform task and the toll that it takes on people. The work of systemic reform is enormously difficult, frustrating, slow-and rewarding. (Little, 1993, p. 140)

Mentoring

In an effort to support new teachers (or an experienced teacher who is making a transition from another subject, grade level, building, or community), a number of schools have paired novice and experienced teachers in an approach referred to as mentoring. New teachers gain support in the form of "opening doors," guidance, access to a positive role model, and a relationship in which it is safe to share doubts and concerns (Newton et al., 1994).

For their part, mentors learn as they listen to issues experienced by first year teachers. To demonstrate and explain their practice in helpful ways, they need to reflect on themselves and their beliefs about teaching. And they gain an increased sense of collegiality and the satisfaction of observing their proteges growth and the recognition that comes with it (Newton et al., 1994).

In highlighting the human link in learning, the process of mentoring attempts from the beginning of novices' teaching careers to set a norm of learning from and with colleagues, in the hope of establishing habits that will be maintained for the rest of their professional lives.

Constraints of Mentoring

gain, time is a constraint, resulting from the tightly scheduled teaching day. Considerable time is required for .urturing constructive relationships between mentors and novices. It may not always be possible to find ideal mentoring matches within a geographic community.

Working Alongside a Curriculum Integration Specialist or Technology Specialist

Regardless of the innovation, support and coaching must follow initial learning experiences. Underlying the role of a curriculum integration specialist or a technology specialist is an understanding that not only novice teachers, but all teachers, require assistance and support as they develop ways to make meaningful use of new tools in their classrooms.

A curriculum integration specialist can provide "ongoing support for people entering the profession, renewal for more experienced teachers, and a vehicle for incorporating teachers' views into general school improvement planning" (Loucks-Horsley et al., 1987, p. 83).

When these curriculum or technology integration specialists are teachers themselves who understand classroom culture and the demands of teaching, their guidance is more relevant and credible to the teachers they work with. When familiar with the regular work in classrooms, these specialists, sometimes referred to as advising teachers or coaches, can help teachers see how technologies can enrich and support learning. They can also help teachers organize and manage technology-based school environments and can play an invaluable role in generating ideas and problem solving with teachers.

One role for the curriculum or technology integration specialist involves collaboration with the classroom teacher: together they bring their combined expertise to team teach a lesson incorporating a new curriculum or technology tool into the classroom. Each brings an area of expertise to the task.

nstraints of Working Alongside Specialist

This approach to professional development depends on the availability of a skilled specialist, who has an

intimate knowledge of both classroom culture and of the innovations being supported. It also requires that that person be available to work with teachers in classrooms during school hours, and to meet with them outside of teaching hours. Although some schools and districts have set aside funding for this kind of support, it is expensive and the individuals are often stretched thin across many schools. Often their time is spent working directly with students rather than in support of teachers.

More fundamentally, there is often a split between the expertise needed for curriculum integration with technology: curriculum specialists may not be well versed in current technology applications, and technology specialists may not have a comprehensive grounding in technology applications. In an ideal situation, the two skills should be found in one specialist, but this is rarely the case.

Use of a Learning Center or Demonstration Center

Also known as teachers' centers, learning centers provide teachers with materials, human resources, and an environment for personal and professional growth. Often learning centers are staffed by advisors or resource teachers with practical experience to offer in the areas of curriculum development and instructional techniques. Teachers come to these centers voluntarily and on their own schedule, to develop materials and projects and to learn from and alongside one another.

Some school districts have established technology resource centers, where teachers can preview and explore different hardware and software options and consult with and be trained by experts about their uses in education.

When teachers see in their students the effects of bringing new approaches and uses of technology into their classrooms, they gain confidence. Many become eager to share their enthusiasm with others in their immediate environment. Some schools have developed on-site demonstration centers, where interested teachers can avail themselves of the opportunity to observe these ideas and tools being applied by more experienced colleagues. In these centers, teachers can work together on collaborative projects using technology and help one another as they proceed. The collegial peer support can be very valuable to teachers as they develop their own confidence and expertise.

Constraints of Using Learning or Demonstration Center

The off-site nature of many learning centers poses an obstacle to easy access. Staffing and scheduling requirements to assure that centers are open during most teachers' available hours can require creative planning and financing. Furthermore, many schools do not have space available that can be devoted to an on-site learning center. With classroom spaces at a premium in many schools, rooms set aside for teacher support may be considered a luxury. Similarly, pressures to spend available technology funds for computers in the classrooms or labs for students can make it difficult to set aside funding for high quality technologies for teachers' exclusive use.

Teacher Collaboratives

> Teachers are in many ways the most isolated of professionals-teaching is still by and large a solo pursuit. Renewed teaching relies on generating new ideas and on having opportunities to examine one's own teaching. A supportive community of practice can help to sustain the slow, stepwise process that eventually leads to a fundamental transformation in teaching philosophy and practice. (Spitzer et al., 1994, p. 1)

Subject-specific collaboratives or communities of practice make it possible for teachers to communicate and collaborate with colleagues, to deepen their knowledge of subject, content, and instruction, and to play leadership roles in educational reform (Little, 1993). According to Lieberman and McLaughlin (1992) successful collaboratives (which can be organized around subject matter, teaching methods, school improvement, or restructuring efforts) share several common features in that they:

- have a shared focus

- encompass varied perspectives and experiences
- form discourse communities
- provide opportunities for leadership
- give teachers ownership of their own learning.

> The independence of many networks from districts or other "official" structures has been a source of strength because it has fostered teachers' sense of ownership and professional safety-perceptions that are essential to the difficult process of unlearning old practices and acquiring new ones. For most teachers, becoming a learner means giving up some appearances of professional authority-admitting uncertainty, admitting incomplete knowledge. Not surprisingly, teachers are hesitant to assume this vulnerable role unless they feel secure in doing so. (Lieberman & Miller, 1992, p. 676)

Teachers need to decide for themselves what their needs are from a network. What some teachers most want is an opportunity to share ideas and information about teaching, learning, and content with colleagues. Others most need support from peers as they work through issues that come with the shifting of roles in the classroom when computers are introduced (for example, when some students' expertise is greater than theirs).

Constraints of Teacher Collaboratives

In the past, networks have been bound by geographic realities, limiting the opportunities for teachers to form affinity groups with like-minded colleagues. When networks require meeting in real time and at a mutually convenient location, teachers are limited in their options. Face-to-face discourse, though important, can be negatively affected by constraints of scheduling and distance.

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Partnerships with Universities or Businesses

Partnerships between schools and outside organizations such as universities, research and development organizations, and businesses come in varied forms. They are based on an understanding that each group can contribute to and learn from its collaborating institution. Professional development is often a centerpiece of those partnerships.

> The Learning-Teaching Collaborative, a partnership between the Brookline, Massachusetts, public schools and Wheelock and Simmons Colleges, focuses on four components of collaboration: Team Teaching (teams of teachers share curriculum and children, five hours a month are allocated for team meetings outside the school day) School/University Collaboration (graduate student interns work full time as team members during the entire school year; teachers lead courses at the colleges) Special Education Collaboration (special needs are fully mainstreamed in many teams; special education teachers are team members) Alternative Professional Teaching (APT) Time (each classroom teacher is provided with a minimum of six hours a week away from the classroom to write curriculum, research, or supervise; full-time interns facilitate this process) (Boles & Troen, 1995) During its first eight years, the collaborative has created an interactive community in which many teachers are leaders. In this new leadership paradigm, teachers fulfill three important roles. First, they are role models to the interns, their colleagues, and the children. Second, they challenge the status quo by co-teaching, discussing practice, and visiting other classrooms. Finally, teachers' involvement in governance, research, college teaching, and writing enable them to make more informed decisions within and beyond the school arena (Boles & Troen, 1995, p. 30).

Because it is vital that programs to educate future teachers work closely with the current teaching forces and share common approaches to teaching and learning, some promising collaborative partnerships have been formed between K-12 public schools and colleges of education. Some of these partnerships have launched statewide staff development projects; others have supported K-12 telecommunications and preservice teacher links; and still others have created technology-rich professional development schools. These professional development schools provide preservice teachers with school-based experiences in observation and practice of technology integration, and add to the research base about how to make schools more productive (OTA, 1995).

Partnerships between businesses and schools have also provided teachers with training in technology. Such opportunities support the efforts of teachers to learn ways in which technologies can be useful in their own lives, as well as in their teaching. For example, the U.S. Tech Corps model described by McConachie offers technical training support to teachers from local business personnel (see p. 119).

No matter what the goals, partnerships with businesses and institution of higher education can build local capacity for school improvement. Partnerships can provide the opportunity to pool resources and can bring in additional resources for comprehensive and relevant staff development. Partnerships can encourage teachers to try on new perspectives, protecting them from becoming too insular and from depending solely on other educators for new techniques and training. Partnerships for staff development can keep teachers in touch with a broader knowledge base and the realities of our society. All parties are enriched by the opportunity to become more familiar with the culture and ways of doing things in different organizations. (Loucks-Horsley 1987, p. 122)

Constraints of Partnerships

Partnerships depend on the proximity of collaborating institutions. In many cases, schools are located far from a teacher education institution that could provide professional development assistance or collaboration. In other cases, local schools and colleges of education may be ill-equipped or lacking expertise or interest in contributing faculty time to professional development. Similarly, local business may not be available or eager to participate in time-consuming partnerships with schools. Business use of technology also may be very different from school applications, minimizing the opportunity for sharing expertise with teachers.

Other Ways Of Supporting Informal Learning

There are a number of other ways in which teachers work in informal contexts that offer learning opportunities. Many teachers have found that writing helps them reflect on their practice. Others have become involved in small group collaborations around particular projects or strands of learning. Still others have formed reflective practice teams. For many teachers, team teaching provides a context for sharing reflections on practice as they work with the ongoing realities, successes, and challenges of teaching.

Teachers also learn through their activities such as developing curriculum, designing programs, planning for technology implementation, previewing and selecting hardware and software, and engaging in systematic school improvement processes. Through reading, discussion, observation, training, or involvement in school improvement processes, teachers can acquire specific knowledge or skills about the issue being examined, and develop broad-based understandings through the experience (Sparks & Loucks-Horsley, 1990).

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WAYS TECHNOLOGIES SUPPORT THE PROCESS OF PROFESSIONAL DEVELOPMENT

The approaches discussed in this paper have been used by schools for a long time, and they hold promise for supporting teachers as they explore ways to make meaningful use of technology in schools. However, the sections above underscore how traditional models of formal and informal professional development have typically been constrained by barriers of time and place. Only recently have educators discovered ways in which technologies can be adapted to support the processes of professional development and break down these persistent barriers of time and space. With the aid of technology, schedules and even time zones can be accommodated, staff can participate from close or distant sites, materials and resources from one context and time can be shared with people in another place and time, and expertise can be made available in even remote locations. The following are some ways in which technology has served as a significant resource for professional development, transcending constraints related to time and distance.

Distance Learning: Expanding Opportunities for Courses and Workshops

Technology can play a significant role in addressing challenges of access to classes and workshops, in which time and place no longer are fixed. With the more informal structure of distance learning (also referred to as netcourses), teachers can participate from varied locations and on their own schedule. Distance learning makes use of any combination of interactive computer conferencing, video and audio tape, and conventional reading matter to allow an instructor and students to interact with one another, independent of time and place.

Teachers can enroll for credit in courses in distance learning programs at universities around the world. Most of these programs follow the traditional university course format in which the instructor lectures, asks and answers questions, assesses student progress, and provides feedback to students about assigned work. In an effort to support reflective practice in ways that traditional courses (provided either in person or through distance learning) cannot, new and informal models of distance learning have emerged, as well.

> The major teaching formats used in face-to-face instruction have been carried over to netcourses. But are there ways of organizing instruction that are unique to netcourses? The ability to form electronic discussion groups; the future ease of generating, sharing, and publishing hypermedia documents; and the possibility of linking to current research on the net are all features netcourses can exploit better than traditional courses. It may well be, once the technology is in place, that netcourse formats will evolve away from traditional courses and become a uniquely powerful instructional medium. (Tinker, 1995, p. 21)

The advantages of distance learning over attending lengthy workshops or enrolling in regular university courses are many:

- *convenience* - flexibility of time and location
- *immediate application* -the option to attend during the school year
- *professional association* - the opportunity to be part of electronic discussion groups, reflecting on shared content with peers from vastly different perspectives, settings, and backgrounds
- *professional growth* - the possibility of enrolling in a wide range of courses
- *economy* - without food, transportation, or housing costs, a netcourse can be provided for one third the cost of residential institutes and half the cost of typical workshops (Tinker, 1995)
- [illegible]

Although there are currently no national standards for information technology in K-12 schools, almost all states and many districts and schools have strategic long-range technology plans. The International Society for Technology in Education (ISTE) is coordinating a national effort to develop national K-12 standards, and the National Council for the Accreditation of Teacher Education (1993) has already established information technology requirements for preservice teachers.

There is general broad agreement on the goals for educational technology (Moursund, 1995): Information technology should be integrated throughout the curriculum, in all subjects and at all grade levels. All students need to learn to make routine and effective use of information technology tools as aids to representing and solving the types of problems that they are studying. All students need to learn to use electronic sources of information and aids to learning.

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The Professional-Development Problem

Professional development is an ongoing part of an educator's life. Teachers are continually faced by changes in the theory and practice of how to be most effective in their teaching areas. School administrators face continual changes in the specific tasks they must accomplish. There are also substantial changes in the makeup of the student body and the needs of the community. Thus, all educators are lifelong learners, actively engaged in adjusting to the evolving demands of their profession.

The information technologies--which can affect content, teaching, and assessment in any academic subject--add a major new dimension to the ongoing professional-development task faced by teachers. The typical teacher is faced by a situation in which:

1. He or she has had limited formal training and experience with the information technologies. This will change as technology becomes more common in the schools and colleges graduating young teachers. But for most teachers, use of computers and related technologies has not been a routine part of their own educational environment. Thus, many teachers lack a functional computer-literacy foundation upon which to build new knowledge and skills.

2. Many students, compared to their teachers, have more computer training and experience, better computer access at home, and more time to spend on learning and using the technology.

3. The applications of information technology in education change at a much faster pace than the teacher has faced in any other area of professional development.

4. The technology infrastructure and support system in the school is relatively weak. Teachers using networked multimedia in a class are on their own if there are any problems with a computer or network connection. The chances are that there is no immediate technical help or replacement equipment.

5. The teachers already feel overwhelmed by the demands of classroom management, assessment, curriculum development, administrative tasks, and other myriad duties. They literally do not have the time to master new technologies and integrate them into their activities.

However, as pointed out by Fullan (1991) and others, professional development that leads to significant and lasting educational change is difficult for the following reasons:

1. Change is multidimensional. We are dealing with change in a school system, and a school system is a very complex entity. Professional development is an important factor in producing change. However, by itself, its value as a change agent is limited. Many other aspects of a school system need to be addressed simultaneously to produce significant and lasting change. For example, are the infrastructure, school administrators, school board, and parents supportive of change?

2. Change is a slow process. It is the nature of a stable and functioning system to resist change. Many school systems are quite resistant to change, and others will only change slowly.

3. Effective inservice is resource-intensive. In many settings, the resources available for inservice education may not be adequate to produce a significant change. To be effective, ongoing professional development is necessary; there has been extensive research showing the shortcomings of one-shot professional development (Moursund, 1989). However, ongoing professional development requires a great deal of time and commitment from the participants, as well as other resources.

4. The inservice often fails to involve key stakeholders. Research strongly supports the need to have school administrators learn alongside their teachers. Teachers, teachers' assistants, school administrators, and school district administrators need to work together to produce school improvements.

5. Adult learning styles are complex. A typical inservice will involve adults with widely varying interests, characteristics, and backgrounds. It is a major challenge to professional development facilitators to meet the varying needs of the participants. Many inservice providers do a relatively poor job of meeting such demands.

6. It is difficult to involve teachers in setting inservice goals and working toward achieving them. As indicated in the 1996 NFIE report, there is substantial research indicating that teachers can and should be involved both in setting professional development goals and in working to accomplish these goals. However, this in itself represents a significant change for most schools.

7. Mechanisms for evaluation of inservice programs are ill-defined and infrequently used. Formative, summative, and residual-impact evaluation are all important to a staff-development endeavor. However, most professional-development activities are inadequately evaluated. Thus, there is little information gathered that supports improvements in the professional development program.

There is substantial research on and practitioner knowledge about how to address and overcome these problems. Excellent summaries are provided in NFIE and NCTAF works previously cited. Both of these documents stress that it will require a major and continuing commitment to excellence in professional development. Both stress the need to empower teachers to play a major role in their own continuing professional development.

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Goals for Information Technology in Education

- Risk-taking Early Adopters
- A Rising Tide of Expectation
- An Effective Inservice Model
- Ineffective Inservice
- Evaluation of Inservices
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Introduction

The installed base of microcomputers, printers, network connectivity, CD-ROM drives, scanners, digital cameras, interactive TV, and other information technologies in schools, homes, and businesses is now quite large, and it continues to grow quite rapidly. For instance, K-12 schools in the United States in the early 1980s had approximately one microcomputer or computer terminal per 120 students. The ratio is now about one per eight students. Moreover, the microcomputers that schools are now buying are several hundred times as powerful as the microcomputers available in the early 1980s. This means that the amount of "compute power" available to students in K-12 schools has grown by a factor of several thousand over 15 years.

The past decade has seen very rapid growth in computer networking. Networking is now commonplace in higher education and in businesses. Many K-12 schools have local areas networks and Internet connectivity. A large number of school districts and a number of states are committed to providing Internet connectivity to all classrooms in their schools. This goal has recently emerged as part of the national agenda of the Clinton administration.

The world's telecommunications system is rapidly becoming digital. We are at the beginnings of a merger of the computer, telephone, and television (Negroponte, 1995). Home access to the World Wide Web is growing very rapidly. A steadily increasing percentage of children are growing up in home environments that include microcomputers, Web connectivity, and other uses of information technologies.

We are now well into the Information and Communication Age. Our school systems are facing the task of dealing with the changes this is bringing to curriculum content, teaching processes, and assessment. One of the major problems that educators face is gaining the knowledge and skills to effectively integrate electronic digital technology into the curriculum. This booklet discusses professional development for educators in the Information and Communication Age.

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Professional Development as Change Agent

Professional development is a major tool for implementing educational change. There is extensive literature on effective inservice education practices, some of it (Moursund, 1989) focused specifically on technology in education.. Two recent reports (National Foundation for the Improvement of Education, 1996; National Commission on Teaching and America's Future, 1996) are helping focus national attention on improving preservice and inservice education. The National Staff Development Council (NSDC) has developed standards at the elementary, middle, and high school levels for staff development. These various reports emphasize that well-prepared teachers are the foundation for school improvement and change.

This document is a draft of one of several reports being prepared for The Road Ahead , a program of the National Foundation for the Improvement of Education (NFIE), a nonprofit foundation of the National Education Association (NEA). The Road Ahead is funded by Bill Gates, co-founder and CEO of Microsoft Corporation , from proceeds from his book by the same name. The program involves 22 school/community partnerships in 15 states using technology-based learning activities that extend beyond the traditional classroom and school day.

This draft is subject to review and revision, and was prepared by staff of the International Society for Technology in Education (ISTE). ***All statements and opinions expressed are those of the authors and do not represent policies or positions of the NEA, NFIE, ISTE, or Microsoft Corporation.***

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Computer Technology and Professional Development: Suggestions for Schools

The information technologies are now pervasive in our society. Rapid growth in availability and use continues unabated. Increasingly, schools are setting specific goals that call for thorough integration of information technologies across the grade levels and across the curriculum.

This means that educators need a professional development system to help them gain knowledge and skills in the information technologies to facilitate their professional work and to help their students learn.

This report examines the professional development challenge in information technology. Key to meeting this challenge is the active involvement of teachers as both learners and as facilitators of their peers' learning. In addition, teachers need to learn from their students.

Links to major headings

- Introduction
- Professional Development as Change Agent
- Goals for Information Technology in Education
- The Professional-Development Problem
- Three Modes of Staff Development
- Adult Education
- Stages of Concern and Levels of Knowledge

- *choice* - the possibility of choosing from a wide variety of options

> PBS Mathline is a year-long professional development course dedicated to assisting middle school mathematics teachers implement the NCTM Standards. Local Public Broadcasting System (PBS) affiliates broadcast video lessons, distribute course materials over the computer network, and offer technical and organizational support to provide participants and their students with a flexible and interactive learning environment.
>
> "The Middle School Math Project, the first of several planned Mathline services, is a year-long professional development course for middle school mathematics teachers. Each Mathline group has approximately 25 teachers-some self-selected, some chosen by their schools-and a mentor teacher. The management of each project is handled locally by the 20 participating public broadcasting stations, representing 16 states. The local stations do more than broadcast video lessons-they also distribute course materials over the computer network and offer technical and organizational support to participantsSThe videos are aired on the local PBS station at a time when teachers can tape them (at home or school) for viewing later at their own convenience, or several times to study key points in detail as they choose. The groups discuss the videos in an online discussion facilitated by a master teacher." (OTA, 1995, p. 84)

These courses highlight the importance of forming communities of learners. Stepping away from their day-to-day responsibilities, participating teachers explore challenging content and reflect together on teaching in a way that supports learning, engaging in a "constructive process that involves doing-solving problems, communicating, reasoning, exploring, inventing, proving-not passively absorbing and imitating" (Honey et al., 1994, p. 166). In these netcourses, the facilitator's role is not to provide all the answers, but rather to support conversation between participating teachers about their various experiences around shared content.

> The goal of the Mathematics Learning Forums (offered by EDC and Bank Street College) is "to provide teachers across the country with on-line professional development experiences that support them in implementing aspects of the National Council of Teachers of Mathematics Standards in their classrooms" (Honey et al., 1994, p. 163). Between eight and ten K-8 teachers join eight-week telecommunications seminars to engage in reflective and instructive conversations about content, learning, teaching, and assessment issues in mathematics. Core topics for different forums have included estimation, cooperative problem solving, engaged learning, or focused observations. The Mathematics Learning Forums Project uses video in two ways: as a powerful tool for modeling teaching practices and techniques and analyzing student thinking, and as a vehicle for teachers to represent their own practice to other forum participants.

Using Video and Integrated Media to Improve Teaching

Live video, CD-ROMs, or videotapes of skilled practice can play a powerful role in offering demonstrations and modeling to teachers when actual observations are hard to arrange. In the Mathline project sponsored by the Public Broadcasting System (see box above), mathematics teachers use a computer network to take part in an online discussion, facilitated by a master teacher, about the mathematics teaching techniques they have observed through video presentations.

> "At Michigan State University, Magdalene Lampert and Deborah Ball use integrated media (also referred to as hypermedia and multimedia) to help teacher education students develop new understandings of the work of teaching and learning mathematics in the elementary classroom. They annotate videotapes and classroom artifacts of inquiry-oriented teaching where students are involved in reasoning, solving problems, and engaging in discussions about mathematical ideas." (Barron & Goldman, 1994)

.deo and integrated media can model diagnostic processes.

> "At Vanderbilt University, Victoria Risco uses video-based case studies in her reading courses for preservice teachers, in order to broaden her students' understanding of children with reading difficulties. They view integrated media presentations of case studies, including multiple sources of information such as video footage of the child reading and of interviews with the parents and teacher, student products, assessment information, and references and abstracts from the literature. These are used as a context for class discussions about factors contributing to disabled readers, and as a model of the case-based approach to diagnosing and addressing reading problems." (Barron & Goldman, 1994)

Analyzing videotapes of one's own teaching is a time-consuming process, but it can be a powerful way to help teachers reflect on their students as learners and on themselves as teachers. In some settings, such as the Talking Math and Cheche Konnen projects described earlier in this paper, participating teachers agreed to be videotaped in their classroom (they determined the content and schedule of the taped sessions). The group then watched the tapes in seminar, and reflected on them together (Storeygard & Fox, 1995; Warren & Rosebery, 1992).

Typically, tapes of teaching practice are developed to present as models of what good practice should look like, but the apparent perfection of such videos often distances teachers from productive reflection. Videotapes of skilled, real-life teachers being interrupted by the intercom, buzzers, bells, and "stuff" of everyday classroom life, are definitely more accessible and identifiable. The personal connection these tapes produce generates very engaging discussions about real-life practice.

(Storeygard & Fox, 1995, p. 29)

In the video *Another Set of Eyes in the Science Classroom* (Rosebery & Smith, in press), teachers talk about three different ways in which they have used video to help them better understand their own practice:

To develop a clearer view of their students' understanding. Setting up the video camera to record a small group's work from start to finish can give a teacher a chance to follow the progression of individual and group thinking (how hard they work, the depth of their thinking, whether and how they check that their answer makes sense, and so on).

To examine her or his own role in the classroom. Watching a video of their own teaching can help teachers distance themselves enough from the situation to see their own practice from a fresh perspective. For example, one teacher notes that he doesn't listen as well as he could: "Sometimes kids 'get it' early on, but I miss it and keep trying to direct conversation in that direction."

To make sense of what students are currently thinking, in order to plan for the next day's lesson. Videotapes of previous classes, combined with collegial feedback, can help teachers design units of study in their classrooms based on their students' evolving thinking.

Using technology, some K-12 schools have created professional development collaborations with universities located too far away for regular visitations.

"The Springfield Public Schools (SPS) District #186 in Illinois has linked one elementary school and one high school with the College of Education at Western Illinois University (WIU), 90 miles away through a real-time, two-way television linkage. The network makes it possible for teacher education candidates to observe live classroom instruction by SPS teachers and for the SPS teachers to take college courses and in-service instruction from WIU professors without leaving the school." (Barker, Helm & Taylor, 1995)

Electronic Communities of Learners: Expanding the Network Base

Through participation in electronic networks, educators can be supported by peers as they learn to develop their own skills and to use new resources for teaching (Newman, 1994). They can reach beyond boundaries of time and place to join electronic professional "communities of practice" through which they break the isolation of teaching and communicate about issues that are of vital importance to them: trouble-shooting, problem solving, sharing reflections, and trading materials and resources (Coladarci, 1993).

collaborative inquiry about a given content area.

Constraints of Inquiry

Again, time and location are often limiting factors for inquiry-based approaches to professional development. Besides the need to schedule regular group meetings, it can be difficult for members to stay connected during the stretches of time between scheduled meetings. It is difficult to sustain these activities, often considered "extras" in the face of more pressing daily teaching commitments. For study groups in particular, the need for knowledgeable leadership to be locally available is also a constraint.

Observation

> A combination of visibility, shared responsibility, and widespread interaction heightens the influence of teachers on one another and on the school as a whole. (Little, 1987, p. 497)

Observation as an approach to professional development is based on a belief that vigorous and durable relationships between teachers can have a demonstrable effect on beliefs and practices of teaching, and that feedback from peers can play a significant role in learning. In this process, which is frequently referred to as peer coaching, teachers pair up and take turns visiting each other's classrooms. On the basis of an initial shared discussion of theory and practice, in which they agree about criteria for classroom observations, participating teachers keep anecdotal records of what teachers and students said during the observation. In a follow-up conference they discuss the data about teaching and learning they observed in each other's classrooms.

This process can benefit both the person being observed and the observer: the person being observed profits from having "another set of eyes" in the room who can provide feedback about actual processes and experiences in the classroom; the observer benefits both from seeing and reflecting on a colleague's practice, and from the process of communicating about the content of the observation. An additional benefit is that the reciprocity of coaching and modeling helps teachers develop their identities as both teachers and learners.

Visits to other schools involved in similar initiatives can also serve as productive contexts for observation.

> For the Critical Friends Program of Co-NECT schools, teams of teachers and administrators from participating schools visit each other periodically in order to familiarize themselves with each other's schools and their restructuring processes. They attend classes, interview the principal and other members of the school design team, "shadow" students, study samples of student work, and speak with parents and other members of the community. The culmination of the visit is a confidential report to the school. "The program gives the Co-NECT community as a whole an opportunity to support each member school in its efforts to dramatically improve the quality of teaching and learning. It also gives visiting teachers an opportunity to reflect on their own practice as viewed in the 'mirror' of the host school classrooms" (Bolt, Beranek & Newman, 1995, p. 29). Thus, the visitor and the visitee simultaneously help and learn from each other.

Constraints of Observation

Several constraints limit possibilities of observation as a widely used approach to professional development, and cross-site visits in particular. It requires availability of the observer during class hours, requiring hiring substitutes for time away from the classroom. Options are limited to sites that are close by, which may not provide a range of desirable observation settings. Additionally, circumstances do not always make it possible

Informal and Job-Embedded Processes

Informal and job-embedded processes are essential to support and extend the learning that takes place in workshops and in classes. These can take place on-site or with near and distant colleagues. Among others, such processes include:

- Inquiry
- Observation
- Mentoring
- Working Alongside a Curriculum Integration Specialist or Teaching Specialist
- Use of Learning Center
- Teacher Collaboratives
- Partnerships with Universities and Businesses
- Other Ways of Supporting Informal Learning

Inquiry

Teachers should no longer simply be expected to be passive conduits of the expertise of university-based research. Rather, they should be encouraged to bring their own expertise to bear upon the questions and issues that are important for them (Cochran-Smith & Lytle, 1993). Teachers' questions bring with them a particular quality of immediacy, as they seek to make sense of how theory relates to the concreteness and particularities of actual practice.

> Teachers' questions often emerge from discrepancies between what is intended and what occurs. Initially, these may be experienced as a concern about a student's progress, a classroom routine that is floundering, conflict or tension among students, or a desire to try out a new approach. This questioning process is highly reflexive, immediate, and referenced to particular children and classroom contexts: What happens when my "high-risk" second graders shift from a basal reading program to a whole language curriculum? How will I know when my students are on the way to thinking like mathematicians and not simply learning new routines? How do my digressions from lesson plans contribute to and/or detract from my goals for the students? (Cochran-Smith & Lytle, 1993, p. 14)

One popular approach to supporting the process of inquiry for teachers is action research, which can provide teachers with an opportunity to learn about teaching through their own active research and to share that learning with the wider community of educators. Action research can provide an ideal structure for individuals or groups to conduct research on uses and impact of new technologies, in their classrooms or in the school.

Cochran-Smith and Lytle define teacher research as "systematic, intentional inquiry by teachers about their own school and classroom work" (1993, p. 24). In this systematic process, teachers identify areas of interest, collect data, analyze the findings, and make changes based on their findings. Though teachers often form action research groups which meet on an ongoing basis, some individuals research questions on their own.

Some argue that the most important element of teacher research is what happens over time, when findings are applied to similar situations and with subsequent classes (Corey, 1953). Others assert that, over and above improving individual practice, the aim of action research initiatives must be to add to the knowledge base about teaching and research itself for the educ ation community (Cochran-Smith & Lytle, 1993).

For some teachers, satisfaction comes with arriving at a deeper understanding of their own practice. For others, regular meetings with a group of fellow teacher researchers brings stimulation, support, and a sense of common direction. Still others are empowered by reaching the wider audience of the educational research community. In common for all is a shared tone of intellectual inquiry.

Teachers' participation as learners in subject area study groups has often deepened their understanding of content and fueled their practice, supporting their students' efforts to make sense of the subject they are exploring.

> In the Talking Mathematics project at TERC (1990-94), TERC staff worked with groups of 12 elementary school teachers in the Boston area during a three-week summer institute and then during biweekly meetings during the school year, to explore mathematical discussion in the classroom. In contrast to many professional development training experiences where teachers come away from a workshop with "activities" to do with their class the next day, Talking Math teachers became involved in working on mathematics "for their own development, regardless of whether the particular mathematics content and problemsScould be used directly with their students" (Russell & Corwin, 1993, p. 556). "Constructing and working through mathematics-feeling the joy of sharing methods, talking about mathematics-enhanced with reflection on teaching through viewing videotapes of one another's practice" (Corwin & Storeygard, 1992, p. 7) made for a powerful combination to enrich their own teaching.

A tremendous synergy between in-classroom and beyond-the-classroom learning can be created when teachers and students, together and independently, engage in active inquiry about content.

> Elementary and middle school teachers of language minority students have participated in Cheche Konnen ("search for knowledge" in Haitian Creole), a TERC-based project, the goal of which is to explore how to create communities of scientific practice in language minority classrooms. Through their own work with long-term inquiries about questions of their own choosing, teachers explore science, teaching and learning, culture and language. In the process, they reflect deeply on scientific and pedagogical practice. "Through their reflective practice, the teachers are constructing a view of science as a socially constituted, meaning-making activity that includes rather than excludes linguistic minority children. This new view of teaching and learning is rooted in the teachers' own appropriation of scientific ways of thinking and knowing" (Warren & Rosebery, 1992, p. 38).

This approach can be very powerful in supporting teachers as they learn to use technology *in the context* of

PUTTING THE PIECES TOGETHER: TWO CASE STUDIES

In the past, it was assumed that the workshop or training method was enough: teachers who attended workshops or training sessions were supposed to come away with the knowledge they needed to apply new curriculum, tools, and pedagogical approaches in their classrooms. What we know now is that what makes professional development effective is the way in which a number of approaches come together and are blended into "collaborative, rigorous programs" (Little, 1986, p. 27), which include a continuum of options. Successful professional development programs in schools are made up of a combination of formal and informal approaches, provided over time, among which teachers can choose and for which they are supported as they build their individual programs.

How can schools or school systems weave such varied initiatives as the ones we have described into an integrated whole? The following three case studies offer various approaches. Whether technology is a resource for professional development overall, or the focus of teacher learning, it takes on a new role in integrative professional development programs.

Schools face particularly significant challenges as they seek to provide effective professional development programs that invite and prepare teachers to make active and informed choices about technology to enhance learning. A study of the field and of specific case studies provides models in which schools link formal and informal approaches to learning and provide teachers with the necessary support. These models reflect broad understandings of contexts for learning. In these contexts teachers actively reflect on and grapple with the meanings of innovations for their practice; they shape their own learning to build a continually growing personal and communal knowledge base; and they are empowered to make changes.

In the first example, the Monterey Model Schools provide a continuum of professional development offerings. Their curriculum intervention plans helped teachers focus on their own particular needs and those of their class. In the second example, TERC's Literacy in a Science Context project, electronic networks provided opportunities for ongoing collegial support for teachers who had taken part in an initial summer institute.

Monterey Model Technology Schools In the Monterey Model Technology Schools "it was recognized that teachers embrace instructional technology use at different rates. By bringing together the technologically naive and fearful with the proficient and adventurous, it is possible to build a climate of mutual support and a culture of school technology use" (OTA, 1995, p. 148).

Emphasis during the first five years was on developing technology implementation projects and on training. In the first year, Technology Awareness Days focused on the subject areas of language arts, mathematics, and science. The intent was to provide the community with a general overview of what can be accomplished with educational technology.

Gradually, with the support of instructional mentoring, the emphasis shifted from broad curriculum areas and operating skills to targeted student outcomes and behaviors. Teachers or teaching teams developed Classroom Intervention Plans (CIPs). Each CIP contained the following elements: curriculum emphasis; desired and measurable end results; necessary hardware, materials, and staff development; evaluation plan; products and procedures for dissemination and; budget. The goal was to develop local expertise in a variety of curriculum applications at the classroom level.

The Monterey Model Schools now provide three types of training and dissemination activities to teachers from Monterey and other districts in California:

- Technology Demonstration Centers (day-long sessions in which teachers demonstrate to groups of other teachers their knowledge of specific applications of technologies in education based on their CIPs)
- Technology Training Seminars (more extensive two-day hands-on training workshops on different technology configurations, culminating with participating teachers developing an individual project to use in their own classrooms)
- Teacher Productions (documents, discs, and videos produced by Monterey Model Schools teachers, showcasing the projects they have implemented in their classrooms) (OTA, 1995).

By offering teachers a continuum of options and access points for learning, the Monterey Models Schools have enabled teachers to focus on learning skills and applications relevant to their personal classroom goals and plans. The Classroom Intervention Plans helped shape that learning into individual and team plans, in order to support carryover of learning into the classroom and sharing of expertise between classrooms. Teacher leadership is encouraged with the invitation to lead Technology Demonstrations Centers and Technology Training Seminars, and to create and share Teacher Productions.

Literacy in a Science Context

The Literacy in a Science Context (LISC) project brought together the strengths of two institutions (TERC and Lesley College) to work with classroom and special education teachers who taught upper elementary students with learning disabilities. The intent of the collaboration was to explore ways in which technology-based interventions in the context of meaningful inquiries into science might improve the literacy skills of all students, and particularly of students with learning disabilities.

Pairs of classroom and special education teachers who taught students in common attended a week-long summer institute. There they used probes connected to microcomputer-based labs (MBL) to conduct investigations on their heart rate, breathing rate, skin temperature, and response time. They learned to use telecommunications in the context of their investigations and as a foundation for their own ongoing collegial communication. And they also reflected on ways of promoting the literacy of students with learning disabilities in the context of science learning.

During the following school year, pairs of classroom and special education teachers returned to their classrooms equipped with sets of MBLs and modems to implement the curriculum. Because participating teachers came from several states, they used a telecommunications network to communicate with one another and with project staff. At the end of the year they came together for a LISC reunion and shared their learning, their struggles, and plans for the following year.

Based on the train-the-trainer model, some participating teachers then provided a series of workshop offerings and online support to teachers in their own school districts. Trainers were supported at a distance through telecommunications with project staff and each other (Weir, 1994; Weir & Storeygard, 1995).

Inquiry, collaboration, and discourse were emphasized throughout the project: face to face during the summer institute, where teachers worked in small groups to conduct investigations about questions of their own choosing; and then at a distance, via the electronic networks as teachers brought the LISC curriculum and approach back to their schools and shared with one another and with the TERC team the successes and dilemmas they encountered in practice. The train the trainer model provided the opportunity for teams of teachers to take on leadership roles in their own districts, and promoted wider dissemination of LISC.

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CONCLUSION

Schools must become places of intellectual challenge. learning and growth. settings which nurture qualities of thinking that set the stage for a lifetime passion for learning. For this to occur. teachers must be provided with rich, varied and empowering contexts for their own development. through formal and informal means of professional support. Technology can provide a means of offering new forms of professional development and support. Many of the features of telecommunications and multimedia technology are particularly promising for overcoming some of the constraints presented in traditional methods of professional development. The challenge now facing educators is finding ways to take what has been learned about professional development and about the uses of technology in learning and use these understandings to bring about rich and effective models of professional growth and support for all teachers.

REFERENCES

Barker, B.O., Helm, V., & Taylor. D.R. (1995). *Reforming teacher education through the integration of advanced technologies: Case study report of a college model.* Paper presented at the 47th Annual Meeting of the American Association of Colleges for Teacher Education. Washington. DC: Western Illinois University.

Barron, L. C., & Goldman, E. S. (1994). Integrating technology with teacher preparation. In B. Means (Ed.), *Technology and education reform: The reality behind the promise.* San Francisco: Jossey-Bass.

Boles, K., & Troen, V. (1995, December). The power of teacher leadership. *Education Bulletin of the Harvard Graduate School of Education* , 20(1).

Bolt, Beranek & Newman, Inc. (1995). *Co-NECT school design guide.* Cambridge, MA: Author.

Brandt, R. (1995, November). On restructuring schools: A conversation with Fred Newman. *Educational Leadership* , 53(3).

Cochran-Smith, M., & Lytle, S. L. (1993). *Inside/Outside: Teacher research and knowledge.* New York: Teachers College Press.

Coladarci, T. (1993, Spring). Introduction. *Journal of Research in Rural Education* , 9(1).

Corey, S. (1953). Action research to improve school practices. New York: Teachers College, Columbia University. Corwin, R. B., & Storeygard, J. (1992). Talking mathematics: Discussion in the classroom. *Connect*, 5(5), 4-7.

Doubler, S. et al. (1994). *Hands-on elementary science project.* Alexandria, VA: Association for Supervision and Curriculum Development.

Fullan, M. G., & Miles, M.B. (1993, April). Getting educational reform right: What works and what doesn't. *Phi Delta Kappan.*

Griffin, G. A. (1991). Interactive staff development: Using what we know. In A. Lieberman & L. Miller (Eds.), *Staff development for education in the 90's: New demands, new realities, new perspectives.* New York: Teachers College Press.

Grimmett. P.. MacKinnon. A.. Erickson. G.. & T. Riecken. (1990). Reflective practice in teacher education. In R. Clift. W. Houston. & M. Pugach. (Eds.). *Encouraging reflective practice in education. an analysis of issues and programs.* New York: Teachers College Press.

Guskey. T. R. (1986). Staff development and the process of teacher change. *Educational Researcher*. 15(5), 5-12.

Hall. G. E.. & Hord. S. M. (1987). *Change in schools: Facilitating the process.* Albany, New York: State University of New York Press.

Honey, M. et al. (1994). The mathematics learning forums online: Using telecommunications as a tool for reflective practice. *Machine-mediated learning* . Hillsdale. NJ: Lawrence Erlbaum Associates.

Levin. J. (1990. April). Teleapprenticeships in globally distributed electronic networks. Paper delivered at the American Educational Research Association. Boston. MA.

Lieberman, A. (1986). *Rethinking school improvement*. New York: Teachers College Press.

Lieberman. A.. & McLaughlin. M. W. (1992. May). Networks for educational change: Powerful and problematic. *Phi Delta Kappan.*

Lieberman. A.. & Miller. L. (1990). Professional development of teachers. *Encyclopedia of educational research. 6th Edition* , New York: MacMillan.

Lieberman, A., & Miller, L. (Ed.). (1991). Revisiting the social realities of teaching. In A. Lieberman, & L. Miller (Eds.), *Staff development for education in the 90's: New demands, new realities. new perspectives.* New York: Teachers College Press.

Little, J. W. (1986). Seductive images and organizational realities in professional development. In A. Lieberman (Ed.), *Rethinking school improvement.* New York: Teachers College Press.

Little, J. W. (1987). Teachers as colleagues. In V. Richardson-Koehler (Ed.), *Educators handbook: A research perspective.* New York: Longman.

Little, J. W. (1993, Summer). Teachers' professional development in a climate of educational reform. *Educational Evaluation and Policy Analysis*, 15(2).

Loucks-Horsley, S. et al. (1987). *Continuing to learn: A guidebook for teacher development.* Andover, Massachusetts: The Regional Laboratory for educational Improvement of the Northeast and Islands.

McLaughlin, M. W. (1991). Enabling professional development: What have we learned? In A. Lieberman & L. Miller (Eds.), *Staff development for education in the 90's: New demands, new realities, new perspectives.* New York: Teachers College Press.

Mergendoller, J. R., & Rockman, S. (1994). Chapter 6: Monterey model technology schools. In *Case studies of exemplary approaches to training teachers to use technology.* Novato, California: Beryl Buck Institute for Education.

National Education Commission on Time and Learning. (1994). *Prisoners of time.* Washington, DC: Author.

Newman, D. (1994). Computer networks: Opportunities or obstacles? In B. Means (Ed.), *Technology and education reform: The reality behind the promise.* San Francisco: Jossey-Bass.

Newton, A. et al. (1994). *Mentoring: A resource & training guide for educators* . Andover, Massachusetts: The Regional Laboratory for Educational improvement of the Northeast and Islands.

Office of Technology Assessment. U.S. Congress. (1995). *Teachers and technology: Making the connection.* OTA-EHR-616. Washington. DC: U.S. Government Printing Office.

Rosebery, A.S.. & Smith. D.A. (In press). *Another set of eyes in the science classroom.* [Video case study]. Portsmouth. NH: Heinemann.

Russell. S J.. & Corwin. R. B. (1993. March). Talking mathematics: 'going slow' and 'letting go'. *Phi Delta Kappan.*

Sarason. S. (1995. October). How to make sure your professional development investment pays off. *The Regional Lab Reports. Newsletter of the Regional Laboratory for Educational Improvement of the Northeast and Islands.*

Schön. D. (1983). *The reflective practitioner*. New York: Basic Books.

Sparks. D. (1994, March 16). A paradigm shift in staff development. *Education Week,* 42.

Sparks. D.. & Loucks-Horsley, S. (1990). Models of staff development. In W.R. Housman. M. Haberman. & J. Sikula (Eds.). *Handbook of research of teacher education.*

Spitzer. W., Wedding, K.. & DiMauro. V. (1994). LabNet: An intentional electronic community for professional development. *Computers in Education* . 24(3).

St. John, M. et al. (1994, January). Reforming elementary science education in urban districts. *Reflections on a Conference, Inverness, California* . National Science Foundation. Grant No. ESI-9354098.

Storeygard, J., & Fox, B. (1995). Reflections on video: One teacher's story. *Journal of Staff Development,* (3).

Tinker, Robert F. (1995, Fall). Netcourses for professional development. *Hands On!*, 18(2). Cambridge, Massachusetts: TERC.

Valli, L. (1990). Moral approaches to reflective practice. In R. Clift, W. Houston, & M. Pugach (Eds.), *Encouraging reflective practice in education, an analysis of issues and programs.* New York: Teachers College Press.

Warren, B., & Rosebery, A.S. (1992). Equity in the future tense: Redefining relationships among teachers, students, and science in linguistic minority classrooms. In W. Secada, E. Fennema, & L. Byrd (Eds.), *New directions in equity for mathematics education.* New York: Cambridge University Press.

Wasley, P. A. (1991a). *Teachers who lead: The rhetoric of reform and the realities of practice.* New York: Teachers College Press.

Wasley, P. A. (1991b). The practical work of teacher leaders: Assumptions, attitudes, and acrophobia. In A. Lieberman & L. Miller (Eds.), *Staff development for education in the 90's: New demands, new realities, new perspectives*. New York: Teachers College Press.

Weakland, R. (1994). Electronic networks enhance apprenticeships of student teachers. In *The Instructional Microcomputing Newsletter*, 9(7).

Weir, S. (1994, March). Literacy in a science context. *Proceedings of 11th International Conference on Technology and Education.*

Weir, S., & Storeygard, J. (1995, Fall). Student literacy through science. *Hands On!*, 18(2). Cambridge, MA: TERC.

Additional Readings

Clift, R. T., Houston, W. R., & Pugach, M. C. (1990). *Encouraging reflective practice in education: An analysis of issues and programs.* New York: Teachers College Press.

Cuban, L. (1986). *Teachers and machines: The classroom use of technology since 1920.* New York: Teachers College Press.

Doubler, S., & Rigby, B. (1995). *Is what I'm doing project work?* Cambridge, Massachusetts: TERC.

Herman, J. L. (1994). Evaluating the effects of technology in school reform. In B. Means (Ed.), *Technology and education reform: Reality behind the promise.* San Francisco: Jossey-Bass.

Holly, P. (1991). Action Research: The missing link in the creation of schools as centers of inquiry. In A. Lieberman & L. Miller (Eds.), *Staff development for education in the 90's: New demands, new realities, new perspectives.* New York: Teachers College Press.

Holmes Group. (1992). *Tomorrow's schools: Principles for the design of professional development schools.* East Lansing, MI: Author.

Hord, S. M., Rutherford, W. L., Huling-Austin, L., & Hall, G. E. (1987). *Taking charge of change.* Alexandria, VA: Association for Supervision and Curriculum Development.

Loucks-Horsley, S., & Stiegelbauer, S. (1991). Using knowledge of change to guide staff development. In A. Lieberman & L. Miller (Eds.), *Staff development for education in the 90's: New demands, new realities, new perspectives..* New York: Teachers College Press.

Means, B. (1994). Introduction: Using technology to advance educational goals. In B. Means (Ed.), *Technology and education reform: The reality behind the promise.* San Francisco: Jossey-Bass.

Mergendoller, J. R. Chapter 1: Introduction. In *Case studies of exemplary approaches to training teachers to use technology.* Novato, California: Beryl Buck Institute for Education.

Mergendoller, J. R., & Johnston, J. Chapter 8: Jefferson County Public Schools. In *Case studies of exemplary approaches to training teachers to use technology.* Novato, California: Beryl Buck Institute for Education.

Muncey, D. E., & McQuillan. (1993, February). Preliminary findings from a five-year study of the coalition of essential schools. *Phi Delta Kappan.*

Muscella, D. (1992, Fall). Reflective practice: A goal for staff development. *Hands On!*, 15(2). Cambridge, Massachusetts: TERC.

Richardson, V. (1990). The evolution of reflective teaching and teacher education. In R. Clift, W. Houston, & M. Pugach (Eds.), *Encouraging reflective practice in education: An analysis of issues and programs.* New York: Teachers College Press.

Rubin, A. (1996, in press). *Educational technology in support of inquiry-based learning,*

Schwartz, J. (1991). Developing an ethos for professional growth: Politics and programs. In A. Lieberman & L. Miller (Eds.), *Staff development for education in the 90's: New demands, new realities, new perspectives.* New York: Teachers College Press.

Siegel, J. (1995, May/June). The state of teacher training. *Electronic Learning.*

Smith, H., & Wigginton, E., with Hocking, K., & Jones, R. E. (1991). Foxfire teacher networks. In A. Lieberman & L. Miller (Eds.), *Staff development for education in the 90's: New demands, new realities, new perspectives*. New York: Teachers College Press.

Stager, G. (1995, October). Laptop schools: Lead the way in professional development. *Educational Leadership*, 53(2).

Vaughan, J. (1990). Foreword. In R. Clift, W. Houston, & M. Pugach (Eds.). *Encouraging reflective practice in education, an analysis of issues and programs.* New York: Teachers College Press.

Warren, B., & Bodwell, M.B. (In press). *"Why do big, heavy boats float?" Teacher inquiry into student learning.* [Video case study]. Portsmouth, NH: Heinemann.

Weissglass, J. (1990). Constructivist listening for empowerment and change. *The Educational Forum*, 54(4).

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Find the Perfect Technology Coordinator

INTERVIEWING TO THE FULLEST

By Richard Alan Smith

Useful interview questions for candidates for the tech-coordinator position in your school or district. Current and prospective tech coordinators can use these questions as a self-study checklist.

As school districts increase their levels of technology acquisition and use, the problem of coordinating of these resources becomes more prominent. Some districts seek to solve the problem by assigning technology-coordination responsibilities to a talented computer-using teacher at each school site. Other districts simply add tech-coordination tasks to the responsibilities of an administrator such as the assistant superintendent for curriculum. Most districts, however create a technology-coordinator position and begin the recruitment process to find the best possible person for the job.

In all situations, care must be taken to make certain that the person selected has the time to do the job and enough knowledge about instructional computing to provide adequate leadership. How can you identify the right person for the difficult job of coordinating the use of technology in your district?

The most important step in the recruitment process is the interview. It is at this point that you have the opportunity to probe the level of professional knowledge that each candidate has. Even if your district plans to assign tech-coordination responsibilities to an administrator in another area, such as curriculum, it is a good idea to make certain that the person is prepared to coordinate the spending of thousands of dollars of technology money.

You will want to learn about each candidate's level of knowledge and experience in four different areas:

1. Technical expertise.
2. Understanding of technology use in the instructional environment.
3. Professional development.
4. [Int]ernet knowledge and experience.

The interview questions on the following pages present a set of guidelines that we have followed in the Houston Independent School District to hire district-level instructional technology coordinators, an Internet coordinator, and an Internet specialist. Each question is designed to separate basic users of technology from those candidates who have taken an active interest in the study of instructional technology and have become professionals in the field (or are one step away from doing so). Several of these questions presented challenges to candidates already employed as tech coordinators in other districts because the questions probe deeper than the candidate's ability to troubleshoot computer installations; they also cover the identification of professional resources in instructional technology.

Although these questions will not apply to every situation, they will get your interviewing committee through most instructional technology interview requirements and help improve the committee's chances of making the right choice.

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INTERVIEW QUESTIONS

These questions will help your interviewing committee assess each technology coordinator candidate's level of knowledge and experience in the main activities that will be required of him or her. Although this list of questions is not exhaustive, it serves as a good starting point because it gives questions that assess both technical skills and professional experience.

TECHNICAL EXPERTISE

Compare and contrast the Macintosh and Windows operating systems.

If you have multiple operating systems in your school, you will want to know how familiar the candidate is with the various systems. Although the candidate can learn additional operating systems, you might want to select a candidate who can begin work with minimal start-up time.

What are the typical types of repair problems likely to be exhibited by computers and peripherals? How would you deal with them?

Computer repairs are a fact of life. Responses to this question will enable you to know if the candidate can identify common repair problems, and may also enable you to discern whether the candidate can differentiate between hardware and software problems. You should also get an idea of what kind of repairs the candidate will be able to handle and the candidate's opinion about the advantages of doing repairs at a district-based facility compared to sending the equipment to an outside contractor.

What are the key elements of a school-based computer network?

Depending on how the candidate responds, you will get a good idea of how technical his or her level of knowledge is with reference to computer networks. For instance, if the candidate only discusses concepts such as networking as a vehicle for the distribution of high-quality software and makes no reference to servers, network cards, cabling, hubs, network operating systems and their features, and so on, you should expect a minimal level of network technical expertise.

The implementation of large-scale instructional technology projects takes a great deal of organization. What do you identify as the key steps in large-scale technology project implementation?

There is a big difference between successfully using computers in the classroom as a teacher and having the knowledge and experience necessary to coordinate the purchase and installation of hundreds of thousands of dollars worth of computer equipment and knowing how to provide teachers with the appropriate technology. You should be listening for key words in the candidate's response such as budget, timetable, bids, requisitions, teacher input, and training.

What are the elements of a well-written proposal for external technology funding?

A knowledgeable response to this question is important if you expect the computer coordinator to simplify the process of finding and obtaining external funding for the use of technology in your district. Listen for phrases such as "get to the point quickly," "base your pr[illegible] research or previous successful projects," and "match the budget to the project description section." Also, look for knowledge of key proposal sections such as needs assessment, goals and objectives, capabilities, project description, and evaluation.

TECHNOLOGY USE IN THE INSTRUCTIONAL ENVIRONMENT

When teaching teachers to use computer laboratories, what are some of the key points of laboratory use and organization that you rank as most important for them to learn?

The candidate should answer this question without hesitation, in a detailed manner, and, of course, in a way that will let you know whether the candidate can help teachers make the best use of computer labs.

When helping teachers use technology in the classroom, what are some of the key points of technology use and classroom organization that you rank as most important for them to learn?

Computer labs are all well and good, but to have a well-rounded program, computers should be placed in the classroom either in addition to or in lieu of labs. In either scenario, the person selected to lead the process should be as knowledgeable about the use of classroom-based computers as he or she is about the use of lab-based computers.

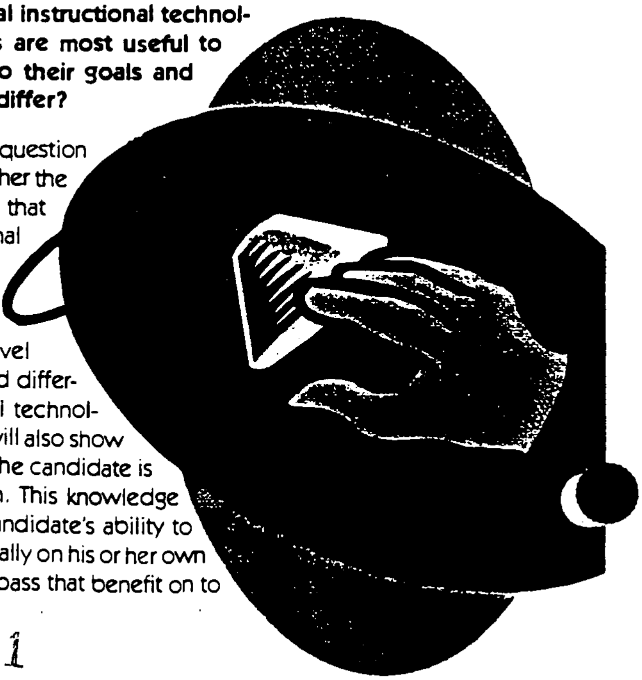
Name some quality instructional software programs. What are their leading characteristics?

This question will identify how much the candidate knows about instructional software. It can be amazing how many candidates struggle to come up with the names of two or three software packages, frequently naming Microsoft Works or other business applications instead of programs like Reader Rabbit.

PROFESSIONAL DEVELOPMENT

Which professional instructional technology organizations are most useful to teachers? How do their goals and target audiences differ?

The answer to this question will show you whether the candidate is aware that there is a professional support structure in the field of instructional computing. The candidate's level of ability to rank and differentiate instructional technology organizations will also show you how involved the candidate is with the profession. This knowledge will indicate the candidate's ability to improve professionally on his or her own knowledge and to pass that benefit on to teachers.



Growth and change in individuals and throughout the system evolves over the course of years: it can easily take five years for large-scale technology infusion to reach initial goals (OTA. 1995). Therefore, expectations must be tempered and resources allocated to sustain an initiative over time. Attention must be paid, too, to how "seed" initiatives will be maintained beyond the initial burst of new activity. Such actions as codifying practices as rules, revising curriculum to accommodate the innovation, establishing professional development committees and school-based planning teams, setting up evaluation procedures that reflect the new practice, and making project-related activities into line items in the regular district budget increase the likelihood that improvement activities will continue over time (Loucks-Horsley et al., 1987).

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PROFESSIONAL DEVELOPMENT APPROACHES

Effective professional development programs encompass both formal and informal means of supporting ongoing teacher learning. No single approach can build a professional community of learners. Rather, it is useful to think of providing a continuum of possibilities, with opportunities and support for teacher-generated learning, discussion, and reflection offered alongside access to outside knowledge. The operative word is flexibility: flexibility for shaping content and process: flexibility for adapting to individual approaches, needs, and preferences: and flexibility for responding to expanding teacher leadership roles.

There are a number of professional development approaches that can introduce and support more collegial, ongoing, and informal contexts for teacher learning overall, and engagement with technology in particular. However, powerful as they are for promoting teacher learning, certain limitations "go with the turf" of many of these approaches. In the section which follows we discuss existing approaches, and their constraints, followed by a section indicating some of the innovative ways in which technologies have been used to handle these constraints.

Formal Processes
Informal and Job-Embedded Processes

Formal Processes

Workshops and Classes

As mentioned at the beginning of this paper, there is a place in professional development for formal learning activities. Well-designed workshops and courses which offer depth and focus, provide adequate opportunities for practice and grappling with ideas, involve doing real work instead of being "talked at," provide opportunities for consultation with colleagues and experts, and make possible follow-up classroom consultation and coaching, can be very effective in imparting new skills to teachers (Little, 1993).

Some of the obvious content of training programs involves the "how to" of specific software applications. Teachers greatly benefit from both instruction about and time to explore new tools.

Workshops can also encompass a range of activities that would not generally fall under the "training" description. In workshop experiences teachers can themselves experience some of the powerful ways in which technology can support learning:

- They can explore for their own learning the use of technology in context, in cooperative group settings, with hands-on inquiries.
- They can research their own questions.
- They can reflect on how new approaches and tools relate to their experience of teaching and learning.
- They can collaboratively work out curriculum-technology implementation plans for their teaching.

In these activities, as they see themselves as learners, teachers grow in their understanding of their students' experience of learning. Some of the most successful workshop programs have involved teachers and students

learning new tools together. In these settings, teachers and students come to view each other as resources to whom they can turn for assistance when they encounter obstacles.

Outside input (such as attending a workshop or a class) must be accompanied by the opportunity to learn through experimentation and self-instruction. Structuring workshops to meet more than once can make it possible for participants to try out new approaches and return to class with questions, comments, and new perceptions (OTA, 1995).

Sometimes it makes sense to bring in outside "experts" to introduce teachers to new ideas, approaches, and tools; still, other alternatives are well worth exploring. An increasingly popular strategy has been the "train the trainers" approach, in which selected teachers take part in intensive training and then bring their newfound expertise back to their own school, by providing demonstrations and on-site training to individuals and groups (OTA, 1995).

The train the trainers method builds local capacity for leadership and expertise with technology and curriculum. It also provides a rich opportunity for extending the intensive workshop or course experiences of a smaller core group to a wider population of school people at a grassroots level (St. John et al., 1994). One caveat in the train the trainer approach is that potential trainers vary in the time it takes for them to reach a comfort level with new materials, tools, and approaches, and to become ready to formally convey their new learning to others. Furthermore, the time and support provided to these trainers is a key to their ability to pass their learning along to their colleagues.

> "In 1984-85 the Jefferson County (Kentucky) School District launched a major four-year plan, called the New Kid in School Project. A 32-unit networked computer lab was installed in each of the district's 87 elementary schools and five teachers from each school were chosen to participate in a 60-hour training program at a central district site. These teachers were then expected to train other teachers in their schools. The district offered participating teachers release time, stipends, and in-service credit for their training activities. Jefferson County used the same training approach when it implemented major technology initiatives in its middle and high schools. An independent evaluation of the New Kid in School Project, six years after its inception, concluded that the trained teachers had emerged as instructional leaders in their schools and took key roles in managing and guiding technology use." (OTA 1995, pp. 145-46)

Constraints of Workshops and Courses

Time and place present the major obstacles to the approach which makes use of workshops and courses. Teachers' school days are full, and securing substitutes is expensive for the districts, as well as time consuming for teachers (see SuperSubs box, p. 89). Many workshops are scheduled at the end of the school day when teachers are exhausted and unable to get the most out of a learning experience, or in the evening or on weekends, when family priorities interfere. Summer provides similar scheduling problems: at the end of the school year, teachers are eager for a break, or find too much time elapses between workshop learning and its application in the classroom setting; in late summer many teachers are preoccupied with preparing for the coming school year.

It is also difficult to create a schedule and to choose a location that will suit the needs of all teachers and of the workshop/course presenters. Schedules and geographic constraints also place restrictions on the availability of skilled presenters and instructors. Too often workshops are offered en masse, at the convenience of the district, the school, or the presenter, rather than tailored to the needs of individual teachers for just-in-time

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Three Modes of Staff Development

This section discusses three different approaches to professional development, each of which can help meet the professional development challenges listed in the previous section.

Large-Group Inservice

Traditionally, professional development has been a large-group activity, such as a university inservice class spread out over a number of weeks, an intensive weekend workshop, or a shorter workshop at a conference or after-school meeting. There is substantial research on how to design and implement large-group inservice activities in a manner that will lead to school improvement. Guidelines for this are provided later in this booklet.

A distinguishing characteristic of large-group professional development is that it is facilitated by a "professional" who often spends a considerable amount of time preparing to do the formal presentations. Although this facilitator may also be a regular classroom teacher, often he or she does not teach in the school of the inservice participants. Thus, this facilitator is typically unavailable to provide follow-up support.

A number of inservice providers have experimented with having students participate alongside educators in large-group inservices. This has proven to be quite a successful approach. The educators learn about their strengths and relative weaknesses as learners compared to students. The educators get used to the idea that it is all right to learn from their students, and students are exposed to a model of lifelong learning.

Teacher-Designed Staff Development

An alternative to the traditional, large-group inservice is making professional development part of the ongoing duties of building-level staff. Joyce and Showers (1988) and NFIE (1996) both focus on schools having teachers play the major roles in organizing and conducting their own professional-development activities.

One excellent way to implement this approach is to have every teacher assume some of the responsibility for professional development in the school. Each individual has a niche, an area in which they maintain knowledge and skill beyond that of the other teachers in the building. The "expert" teacher then has a responsibility to help colleagues improve their capabilities. The whole volume of information on educational technology--thousands of articles published each year and thousands of products coming to market--is impossible for any individual to digest. However it is quite possible for a teacher to become expert in one or two ideas or products that meet particular needs in a school.

The actual instruction in this model may occur in a one-on-one or small-group setting. It may be informal and spontaneous. The faculty expert on the World Wide Web may step across the hall to help a colleague connect to the Internet. The expert on electronic assessment may end up giving an impromptu demonstration when he or she brings a laptop to the teachers' lounge to work on grades.

Students as Professional-Development Facilitators

Still another important professional development approach is learning from and with one's students. This is especially effective in settings in which

students work in cooperative learning groups that make extensive use of computer technology. The students learn from each other. The teacher becomes just one more member of this learning community. The teacher models being a lifelong learner who is able and willing to learn from anyone who has the appropriate knowledge and skills.

This approach to professional development fits well with the other two. It is "learning by doing," and it can become a standard part of a teacher's repertoire. Indeed, whenever the teacher encounters software or curriculum ideas that might be relevant to a class, the teacher can ask the students for help in exploring the software and curriculum ideas. The students can become part of the team that helps bring new software and ideas into the curriculum.

Many schools have experimented with giving students significant levels of responsibility for the information technologies in their school. Students run computer networks, evaluate software, and participate in a licensure procedure through which other students demonstrate their mastery of hardware and software. For example, the public schools in Olympia, Washington, provide excellent examples of students running the computer networks, evaluating hardware and software, and helping both their fellow students and their teachers learn about the information technologies.

In a comprehensive professional-development plan for technology in education, all three of these approaches can be effective. Both large-group and one-on-one professional development can be done using the Internet or other distance education modes. In both cases, it is important that the learning facilitator have an understanding of how adults learn and how to work with adults in both formal and informal learning situations.

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Adult Education

There has been a great deal of research on adult education and the specifics of effective inservice for educators. Some key findings:

1. Adults learn by doing; they want and need to be involved. Mere demonstration is seldom effective--practice and coaching are highly desirable.

2. Problems and examples must be realistic and relevant to their specific professional needs. Changes in pace and instructional method help keep the interest of the adult learner high. Handout materials should be designed to specifically fit the needs of educators as they apply what they are learning to their professional work. Teachers especially appreciate receiving detailed lesson plans and student handout materials, along with help in learning how to use them.

3. Adults relate their learning very strongly to what they already know. They tend to have a lower tolerance for ambiguity than children, so explicit attachment of new knowledge to their existing base is a paramount necessity.

4. Adults tend to prefer informal learning environments, which are less likely to produce tension and anxiety. Instruction carried out in the environment similar to that in which implementation is expected is highly desirable.

5. Unless the conditions of training absolutely require it, a grading system should be avoided. Checklists of criteria met in the course of training, for example, are less intimidating than the assignment of grades.

INTERVIEW QUESTIONS

Have you made instructional technology presentations at conferences or had instructional technology articles published? If so, at which conferences and in which journals did your work appear? What topics did you cover?

The candidate's response to this question will show you how active he or she is in the field of instructional computing. From the topics of the articles published or presentations made you will be able to find out what the candidate considers to be his or her particular strengths.

Which magazines and journals do you think would be most helpful to teachers as sources of instructional technology project information and research findings?

Although the candidate may not be active in professional organizations, make presentations at conferences, or write articles, he or she should be able to identify magazines or journals that provide a constant source of new instructional computing information. An in-depth response to this question is important because it will indicate that the candidate is capable, at least on some level, of professional development on his or her own, which can then be passed on to teachers.

INTERNET KNOWLEDGE AND EXPERIENCE

What is the Internet and how can it be used to improve education?

Although many people have a vague idea of what the Internet is, few understand its underlying structure. The candidate should be able to identify the Internet as a network of networks that allows people in various sites around the world to communicate as if they were on a local area network. The candidate should also be able to convey that the Internet can be used for such things as sending and receiving e-mail, logging on to remote computers, sending and retrieving files, and looking for information using FTP, Gopher, and the World Wide Web.

But, just knowing what the Internet is won't be enough. The candidate should also demonstrate that he or she knows how it can be used to improve instruction. Look for evidence that the candidate realizes that the Internet can be used to increase access to instructional resources, help with teachers' professional development, and enable students to communicate with students from diverse cultures around the world.

What is the World Wide Web?

This is another question designed to differentiate a candidate at the user level of Internet knowledge from a candidate with a deeper understanding of what is being used. The response should indicate that the candidate knows that the Web is a distributed system of information that is entered using a graphical user interface.

Describe the relationship of HTML to the World Wide Web.

If the candidate knows that HTML is a programming language that enables authors to embed links to other documents on the Web in a standard fashion and goes on to describe the authoring process, you will know that the candidate's level of Internet knowledge goes beyond the level of casual user.

Describe your involvement with an instructional Internet project.

The answer to this question will let you know if your candidate has any hands-on experience using the Internet for instruction and give you an idea of the candidate's depth of experience with the Internet.

Name some Internet services or sites that would be useful to teachers and students.

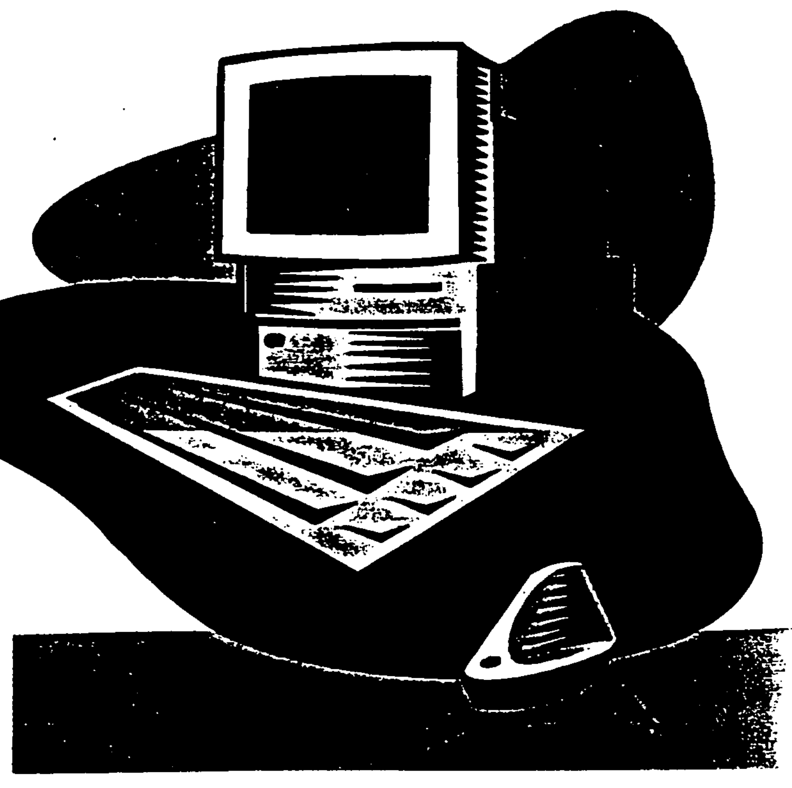
Technical knowledge of the Internet is one thing; knowing where to go for information that will be useful to teachers and students is something else, and, for our purposes, it is equally important. Typical knowledgeable responses would suggests sites such as the AskERIC Virtual Library, KIDLINK, Learning Connection, NASA Educational Resources, and World Wide Web Armadillo.

How would you increase the number of teachers and students who use the Internet for instruction and learning?

Here we are looking for the "vision thing." Use of the Internet and the Web for the improvement of instruction is not necessarily intuitive for teachers (and many administrators for that matter). The candidate should be able to provide a sense of how to impart the importance of the Internet to teachers and be able to talk intelligently about the hardware, software, networks, and phone lines necessary to make it work.

Describe the steps you would take to ensure that students do not access material on the Internet that is inappropriate for their use because of the material's sexual or political content.

The canidate's response to this question will let you know whether he or she has thought about the subject at all and if he or she can suggest practical steps. The candidate should indicate that he or she would review other districts' policies before suggesting a new policy for your district.



Second and Third Generations

After a year of support and independent practice in their classrooms, each first-generation teacher attended a second summer technology institute. There, guided by a facilitator, each teacher mentored two "second-generation teachers." They not only passed on what they knew but also continued their own development. And they continued meeting twice a month, as before.

Why did each first-generation teacher mentor *two* second-generation teachers? If each first-generation teacher trained only one teacher, it might be difficult to tell whether confusion over a concept or a piece of technology was due to the mentor's approach or the mentee's lack of understanding. But if two mentees were confused, then it was incumbent on the mentor (with the facilitator's help if necessary) to re-teach the concept. Also, if one teacher understands a concept and the other one doesn't, one teacher can help the other. When learning complex concepts, novices need to be able to commiserate, collaborate, and communicate. A peer at the same level of expertise provides that support.

This process continued for a third year. Each second-generation teacher took on the role of mentor for one third-generation teacher. The role of the technology facilitators shifted to that of resource people. Eventually, all teachers in the district can learn how to use technology. Each new generation of teachers will have the support of both their peers and the previous generation. The facilitators, administrators, and teachers continue to evaluate what works and what is possible.

We purposely waited a year to start the program for the second-generation teachers. When we had first attempted to implement the generational model, we started the new generations too quickly. The first-generation teachers needed more than one semester to understand how to integrate technology into the curriculum. Moreover, the second-generation teachers did not start with an intensive summer institute. Instead, they were *trained* in technology (rather than *educated*) during the monthly meetings. Consequently, they did not have an opportunity to identify themselves as a group separate from the first-generation teachers, and they accomplished little in terms of technology integration or unit development.

A Catalyst for Change

In the end, the district's policies—and professional roles—changed in many ways. District administrators extended the generational model across the grade levels and to other schools. Primary grade teachers began to take responsibility for their professional development (Peterson et al. 1997), which evolved into reading instruction supported by technology. Librarians explored their role on the instructional team and collaborated with teachers in planning and teaching units.

Principals discovered they needed different ways to evaluate teachers. Teachers were giving up control in the classroom, letting students teach one another and teach the teacher. Rather than looking at teachers' direct instruction, principals needed to evaluate how teachers were guiding student interactions and learning. The principals also came to accept the fact that their teachers had greater expertise in technology than they did, and they began using teachers as technology resources. They also encouraged teachers to learn more, and they did so themselves.

As for the teachers, they developed confidence and tolerance for ambiguity as they recognized their ability to diagnose most problems and reason out potential solutions on their own. Initially, for example, some female teachers looked to the male teachers to do the routine tasks such as uncrating and hooking up printers, setting up networks, and diagnosing error messages. Once we made these women aware of this, they took on these roles and were surprised at their success.

Similarly, the teams of first-generation teachers at the high school looked to us for solutions when they had to develop interdisciplinary units without having the same students in all the classes. Rather than giving them an answer, we asked them to work out the logistics. They used their technological expertise to come up with ways to collect and share data, collaborate on hyperstack presentations, and so on, before their classrooms were networked.

Most important, teachers' notions of teaching, learning, and technology changed. For most teachers in the district, technology was a new area of professional development. Thus, they often reverted back to the role of novice learner. This caused them to rethink how they learned something new and what motivated them to do it, giving them greater insight into their students' learning processes. They then reconsidered their own teaching strategies, their role in the classroom, the contributions

FIGURE 1

Technology Boot Camp: Software Taught for Various Functions

Word processing:	ClarisWorks, Microsoft Word
Databases:	ClarisWorks
Spreadsheets:	ClarisWorks, Excel
Outlining:	Inspiration, MORE
Desktop publishing:	ClarisWorks, Microsoft Word
Graphics:	ClarisWorks
Presentation packages:	ClarisWorks, Inspiration, PowerPoint
Audio and video capture:	Apple VideoPlayer, PhotoFlash, Video Shop
Hypermedia:	HyperStudio
World Wide Web searches and authoring:	Netscape, PageMill, Web Workshop
Authoring:	Imagination Express, KidPix Studio, Living Books, Once Upon a Time, StoryBook Weaver, Writing Center

David C. Caverly, Cynthia L. Peterson,
and Thomas F. Mandeville

A Generational Model for Professional Development

In this model, teachers learn technology from an instructionally strong "first generation" of teachers, practice what they have learned, and pass on their expertise to a second generation of teachers, who pass it on to a third.

Schools have been acquiring computers for more than a decade. Teachers have been participating in computer training for a decade. Yet many teachers still are unable to use those computers to help students learn more effectively. On a quick tour of schools in any given district, we might find any one of the following: a classroom computer on a teacher's desk, turned toward the teacher's chair; computers loaded with electronic worksheets and instructional games for students who have finished other work; students visiting the computer lab once every two to three weeks to learn keyboarding or to use a word processor to write a paper from a rough draft; and computers sitting in boxes in a storage room because administrators are waiting for computer tables.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Obviously, the problem is not with the technology but with the educators' training. As Schofield (1995) points out, computers often do not live up to their promise because no one shows teachers how to integrate their new technology into their instruction or, sadly, into their students' learning processes. Thus, when teachers want to go beyond using technology for data input or for motivating youngsters, they face a huge learning hurdle.

Educating—Not Training

In our generational model, we educate teachers in the integration of technology into their curriculum and in ways to enhance, and perhaps even change, the way they help students learn. In Piagetian terms, we help teachers *accommodate* new knowledge rather than simply *assimilate* another process or piece of curriculum. Because technology changes rapidly, technology training is an ongoing need—not a short-term fix. Thus a more productive notion than training is *educating* teachers and administrators in the use of technology, so that as new technology comes along, they can train themselves.

We use the word *educating* to emphasize the need for teachers to think differently about rather than merely know what to do with. This runs counter to traditional staff developmental models and most entrepreneurial training efforts. We also prefer to use the term *technology* instead of *computers* to designate a

new type of thinking made possible by computers and computer programs. Though many people use the terms interchangeably, computers are merely the machines and their peripherals.

Our generational model for educating teachers features a structure that operates like our own life cycle: We spend time intensively learning from the previous generation, practice what we have learned on our own, and then, over time, hand down life's lessons to the next generation.

Our model grew out of a social-constructivist approach to professional development (Mandeville et al. 1995). It is also a result of a collaboration between Southwest Texas State University's education department and New Braunfels Independent School District in the Texas town by that name. (Third grader Mikey Caverly complained to his dad—a professor at the university—that he didn't get to use the computers at school.)

The school district had acquired some technology over the years and offered teachers one-day workshops on computer programs. But by the time they figured out how to apply the software in the curriculum, they had forgotten how to use it. The teachers' peers typically had forgotten, too, and, in any case, they had precious little time to help. Finally, the district was awarded three grants to develop a better approach to the education of teachers in technology, programs that became known as Project TEACH, Project LEARN, and Project READ.

Technology Boot Camp

At the outset, the school principals and college faculty identified a group of instructionally strong "first-generation teachers." Over the summer, these teachers attended a three-week technology institute—technology boot camp, as some called it—where a facilitator showed them how to use technology to support interdisciplinary, thematic units. The teachers learned

Children in New Braunfels, Texas, pursue projects independently after group work. Their teachers use technology to encourage collaborative learning.

how to use a variety of software (see fig. 1).

The district provided each teacher with two PowerMac (model 5360) computers with printers and software. The computers were equipped with CD-ROM, extended RAM (24K), and video in/out ports. The teachers used one computer at the institute sessions and the other to practice on at home. When school started in the fall, they placed both computers in their classroom.

In collaborative guided practice, groups of three teachers applied what they learned to a similar classroom task or learning experience. (We've provided sample solutions to various classroom tasks at our Web site: http://www.schooledu.swt.edu/Faculty/Caverly/Grants).

The groups of teachers formed bonds and developed camaraderie. They learned they could depend on one another to help make instructional decisions. Typically, each member of the group became more expert than others in some areas and, therefore a resource for those whose strengths lay elsewhere.

Guided and Independent Practice

At the start of the school year in the fall, the teachers met with the facilitators twice a month for continued guided practice as they applied the technology in their own classroom. One day a month, the teachers were released from their classroom duties to create interdisciplinary units and to integrate technology into those units. The facilitators visited the teachers to answer questions and help them extend their knowledge.

One evening a month, the teachers from all of the campuses met to share their curriculum units, evaluate how effective the units were, and generate additional applications. The facilitators joined this learning community to help teachers further integrate their teaching and evaluate their use of technology.

As a result of these two monthly meetings, the teachers' support structure was broadened and strengthened, leading them to substantively change their approach to instruction and their thinking about technology. Their motivation was evident as they reported on their students' progress and shared students' products with a number of groups—faculty members, parents at a Saturday morning open house, community organizations, the school board, and peers at professional conferences. They held an open house in their school library. The teachers brought their computers, networked them, shared programs, and prepared impressive displays of student work. They also had students demonstrate what they had learned.

The teachers had moved from awareness to knowledge to control as they first observed someone demonstrating the technology and then engaged in both guided and independent practice.

arget Indicators	In Progress	Essential	Proficient	Advanced
ollows Guidelines nd Etiquette when Using Electronic Information Resources	• Someone tells me how to use the information resources, and works with me to get the information I need. • I spend so much time using the resources that I deny access for others. • I need to be reminded of the guidelines for using electronic resources responsibly.	• I have been trained to use electronic resources, can use them with minimal supervision, and can usually get the information I need without help. • I share electronic resources and try to follow appropriate guidelines for their use.	• I get the information I need in a reasonable amount of time so others can also use the m aterials. • I follow guidelines for the use of information resources and use them efficiently.	• I serve as a mentor for others who want to learn how to use electronic resources. • I use my skills to promote positive and ethical uses of those resources. • I use the materials and equipment fairly and carefully.
Maintains the hysical Integrity of Information Resources and Facilities	• I know that information resources / facilities have rules and consequences, and sometimes I follow those rules.	• I usually follow the rules in my school for use of information resources, and accept the consequences when I occasionally break a rule. • I never intentionally cause damage to any materials or equipment.	• I respect the rights of others by following the rules, and never intentionally keep materials from being available to them. • I tell someone immediately about any damage I cause or discover.	• I appreciate the many resources and facilities that are available to me. • I help others follow the rules for the use of equipment and materials. • I use materials fairly, carefully, and equitably. • I suggest new rules when appropriate.
ecognizes the Need or Equal Access to Materials and Resources	• I use some information resources. • Sometimes I only use items from home or my classroom, but might go to the library media center during a sche duled class time. • I don't care if someone else needs to use the information I have. • I don't like to share.	• I go the library media center when I need information resources. • When my library doesn't have what I need, I know I can ask the media specialist/librarian to help me find it from another source.	• I know it is important for others to have access to information r esources, so I usually return items when the are due. • When I need other materials that are not in my school, I look for them on ACLIN, or other suitable networks, and work with my library media specialist to borrow from other sources.	• I use several libraries and on-line sources when necessary and appropriate to find information I need. • I share resources with others when it is helpful. • I follow the rules in all buildings, including returning all materials on time.

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Students as Group Contributors [Information] Guideline #4

Target Indicators	In Progress	Essential	Proficient	Advanced
Helps Group to Determine Information Needs	• I do not participate constructively in a group. • I sometimes distract the group. •I rely on others to decide what information is needed.	• I usually participate to determine the information needs of the group.	• I am willing to do what is needed to help determine the information needs of the group.	•I assume my appropriate role in the group. • I am comfortable leading, facilitating, negotiating, or participating in defining the information needs of the group.
Shares Responsibility for Planning and Producing a Quality Product	• I am not a part of the group, and/or rarely take responsibility to help plan the group's information needs.	• I help define the jobs, and assume some responsibility in assisting with task compl etion.	• I help to define jobs, and am actively responsible in helping to complete the task.	• I help the group go beyond the basic resources. • I am responsible for helping synthesize the ideas into a finished product.
[C]ollaborates to Determine Relevant Information	• I have trouble participating in a group, or take over and don't listen to the ideas of others.	• I sometimes participate in selecting, organizing, and integrating information for some sources.	• I work with others to select, organize, and integrate information from a variety of sources.	• I actively work with others and help the group select, organize, and integrate information from a variety of sources.
[Ac]knowledges Diverse Ideas and Incorporates them When Appropriate	• I need support to work in a group. I often do not respect input from others.	• I show respect for the ideas of others.	• I encourage team members to share ideas.	• I respect and help the group find and incorporate diverse ideas.
[O]ffers Useful Information to the Group, Defends Infor-mation When Appropriate, and Seeks Consensus to Achieve a Stronger Product	• I sometimes make the group's progress difficult.	• I offer information or ideas, but am unable to defend my own ideas, or those of others.	• I offer and defend information that is brought to the group.	• I offer useful information to the group, defend that information when appropriate, and seek consensus to achieve a stronger product.
Clearly Communicates Ideas in Presenting the group Product	• I choose not to participate in the presentation, or am unprepared to make a good presentation. • Sometimes I am disruptive.	• I help in presenting the group product.	• I contribute to the group and demonstrate the ability to use a variety of presentation met hods.	• I work hard in assuring that all contributions from the group are included in the final product. • I help the group present effectively using a variety of media.
[E]valuates Product, Process, and Individual Roles Continuously	• I don't work with a group and am not certain how to evaluate the process or pro duct.	• I evaluate my own role, but need support to apply certain criteria to the group product. • I am more comfortable allowing others to do the work.	• I effectively evaluate my own role and the roles of others. • I continuously apply appropriate evaluation criteria to the group product.	• I work with the group to evaluate roles, and apply appropriate evaluation criteria to process the product. • I suggest improvements for the next project.

Students as Responsible Information Users: Information Guideline 5

Target Indicators	In Progress	Essential	Proficient	Advanced
Practices Ethical Usage of Information and Information Sources	• I don't give credit to others when I use their information. • I don't know why some things need quote marks, and have trouble putting information in my own words. • I don't know why I can't use other people's work (from books, or other information resources).	• I can usually put information in my own words. • If I use someone else's words, I usually remember to put them in quotes. • I can create a bibliography to credit my sources, and don't copy other people's work. • I know it's against the law to copy computer disks, tapes, or other materials.	• I follow copyright laws and guidelines by giving credit to all quotes and ideas, citing them in notes and bibliography properly. • I only make copies of print, software, or tapes when I can locate permission from the author/publisher, or by locating permission on the materials.	• I understand and appreciate that copyright protects the creator of the resource, so I always follow and uphold copyright regulations. • I do not plagiarize. • I cite all my sources by following a format demonstrated to me by a teacher or other source. • When I need to copy something, I know how to, and do get permission from the copyright holder.
Respects Principle of Intellectual Freedom	• I usually don't pay attention to what others read, listen to, or view, and sometimes react inappropriately to them.	• I don't try to keep someone from expressing their own ideas, nor reading, listening to, or viewing what they want.	• I understand it is important to have many and differing perspectives on a subject. • I know I have the right to express my opinion, and usually offer my opinion in an appropriate manner.	• I can explain my First Amendment rights, and if challenged, know the process available to me to defend those rights. • I promote the rights of others, and defend them as well.

Students as Quality Producers: Information Guideline #2

'arget Indicators	In Progress	Essential	Proficient	Advanced
Recognizes Quality and Craftsmanship	• I need help understanding what makes a good product, and how to create it.	• I look at the available products and sometimes see what is needed to create my own.	• I look at several products, evaluate them, and know what I need to do.	• I look at several products provided to me by my instructor, critique them, and see ways to make a better product.
Plans the Quality Product	• I need help to understand the steps needed to plan my work. I like someone to help me with each step in completing the product.	• I need to be shown the steps to make my plan, and then can work on my own.	• I know the steps necessary for completing my product and make a plan to complete it.	• I create a process and a timeline (with a back-up plan) for all the steps needed to complete my product
Creates a Quality Product	• I need help to find which sources to use. I don't know how to use the facts to solve the problem. I have trouble creating the product.	• I use the minimum sources assigned. I just list the facts. I always use the same sources for other work.	• I create and improve my product by using a variety of resources from the media center or school.	• I compare and contrast facts from a variety of sources available both in and out of my community. I am comfortable using various media for products and audiences. I discover new sources on my own.
Presents a Quality Product	• My product is incomplete. I don't revise.	• I complete, but need help with revisions to my product.	• I complete, practice, and revise my product.	• I complete, practice, and revise my product several times. I ask others to give me feedback.
Evaluates Quality Product	• I don't know how to make my product better.	• I need help to understand the best part of my product, and what could have been improved.	• I understand why my product is good, and what could make it better.	• I exceed my expectations when producing and improving a quality product.

Students as Self-Directed Learners: Information Guideline #3

Target Indicators	In Progress	Essential	Proficient	Advanced
Voluntarily Establishes Clear Information Goals and Manages Progress	• Setting information goals is difficult for me. • I need help from someone to choose what I'm supposed to do. • I work best with problems that have only one answer.	• I can set some information goals by myself. • I can sometimes find what I'm supposed to do on my own. • I see that sometimes there may be more than one solution for my project or pro blem.	• I almost always set my own information goals. • I can usually find a variety of information resources to achieve those goals. • When there is more than one solution, I choose the appropriate one for my project or problem.	• I can set my own information goals, and choose the best way to achieve them. • I like to explore and evaluate various resources and solutions. I use them to create a new solution to the problem. • I'm comfortable in situations where there are multiple answers, or no "best" answer.
Voluntarily Consults Media Sources	• I usually use the easiest source, and only one source.	• I can do what is asked of me, and usually find answers to questions after consulting a few sources.	• I understand how different sources are organized, and look for the ones that best meet my needs.	• I look at many different sources to find those that meet my needs. I consider various point-of-view and the merits of the resources before choosing those that work best for me.
Explores Topics of Interest	• I have trouble enjoying my reading, and have a hard time staying with a book -- or other reading material. • I tend to over-use certain information resources to the exclusion of others when I do read. • I have trouble exploring new topics. Someone needs to help me get started.	• I enjoy reading certain types of books and other information resources. • I usually read only about one subject, or stay with one author's works. • I explore new topics when required.	• I like reading several different types of literature. • I enjoy reading in a variety of formats (e.g. books, CD-ROM, and other media). • I read to explore and learn about a variety of topics.	• Reading is very important to me, and I enjoy reading and exploring many different to pics • I use information resources for information and personal needs, and actively seek answers to questions. • I consider alternative perspectives and evaluate differing points-of-view. • I read for pleasure, to learn, and to solve problems
Identifies and Applies Personal Performance Guidelines	• I just do what I'm told. Someone tells me if it's good or not.	• I know when I've done a good job.	• I know when I've done a good job, and know why I was successful. I am satisfied with the results.	• I know how I learn best, and can choose the method(s) which guarantees my success. I can evaluate what I've done. I'm not always satisfied with my results.

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Students as Knowledge Seekers: In mation Guideline #1 (Part 1)

arget Indicators	In Progress	Essential	Proficient	Advanced
Determines 'nformation Needs	• I need someone to tell me the topic and what information I need.	• I need someone to define the topic. I can identify, with help, some of the information I need.	• I determine a topic and identify the information I need.	• I determine a manageable topic and identify the kinds of information I need to support the topic.
Develops ıformation Seeking Strategies and ocates Information	• Someone else selects the information resources I need and shows me how to find the information. • Someone else develops my plan and timeline. • I do not know what to record when doing research, nor what bibliographic information is.	• I select resources but they are not always appropriate. • I have an incomplete plan. I have a timeline, but don't always stick to it. • I return to the same source to find the bibliographic details.	• I use a variety of information strategies and resources. • I have a complete plan and stay on my timeline. • I sometimes record bibliographic information.	• I always select appropriate strategies and resources. • I have a complete plan and can adjust my timeline when needed. • I always record bibliographic information for all my sources.
Acquires Information	• I don't understand how to use information resources. • Someone helps me extract details from information.	• I do not use a variety of information resources. • I can extract details and concepts from one type of information r esource.	• I prefer to limit the number of information resources I use. • I extract details and concepts from different types of r esources.	• I am comfortable using various information resources. • I extract details and concepts from all types of resources.
Analyzes Information	• I have no way to determine what information to keep, and what to discard. • Someone helps me decide what information to use.	• I sometimes apply appropriate criteria to decide which information to use. • I don't always know what criteria to use.	• I examine my information and apply criteria to decide what to use. • I usually know what criteria to use.	• I effectively apply criteria to decide what information to use. • I can match criteria with needs.

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Students as Knowledge Seekers: Information Guideline #1 (Part 2)

arget Indicators	In Progress	Essential	Proficient	Advanced
Organizes Information	• I try to organize information, but have trouble and have to ask for help. • I need to be reminded to credit sources.	• I know some ways to organize information. I can use one or two very well. • Sometimes I credit sources appropriately.	• I organize information in different ways. • I usually credit sources appropriately.	• I choose to organize information in a way that matches my learning style and/or to best meet my information needs. • I always credit sources appropriately.
Processes Information	• I put information together without processing it.	• I combine information to create meaning. I draw co nclusions.	• I integrate information from a variety of sources to create meaning that connects with prior knowledge. I can draw conclusions on my own from my sources.	• I integrate information to create meaning that connects with prior knowledge and draw clear and appropriate conclusions. I provide specific and supportive details.
cts on Information	• I am not sure what actions to take based on my information needs. • I ask for help to find everything I need.	• I know what to do with the information I find. • Some of the information I find is appropriate to my needs.	• I act based on the information I have collected and pro cessed. • I do this in a way that is appropriate to my needs.	• I act independently of the information I have collected and processed. • I do this in a way that is appropriate to my needs. I can explain my actions so that others understand.
Evaluates Process and Product	• I don't know how I did. I need someone to help me figure out how to improve.	• I know how well I did and have a few ideas on how to improve next time.	• I know when I've done a good job, and know when there are things I could have done better. I make some r evisions.	• I evaluate the product and the process throughout my work, and make revisions when necessary.

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Colorado State Board of Education

Seated January 10, 1995

Patricia M. Hayes, Chairman *Englewood*	6th Congressional District
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Colorado Department of Education Mission:

"To lead, to serve, and to promote quality education for all"

William T. Randall
Commissioner of Education
State of Colorado

Nancy M. Bolt
Assistant Commissioner
State Library and Adult Education Office
201 E. Colfax Avenue
Denver, CO 80203
303-866-6909

Purpose of this publication: To provide meaningful examples of what a learner should know and can do, in the context of information literacy. These rubrics are designed to be used by any stakeholders in education: media specialists, teachers, administrators, staff, students, and parents.

Funding for this project was provided by the Colorado State Library and Adult Education Office, and the Colorado Educational Media Association (CEMA). Nongovernmental sources are funding 25% of this project.

Target Indicators	In Progress	Essential	Proficient	Advanced
Student as a Knowledge Seeker	• I need someone to tell me when I need information, what information I need, and help me find it.	• Sometimes I can identify my information needs. I ask for help finding and using information.	• I am able to determine when I have a need for information. I often solve problems by using a variety of information resources.	• I know my information needs. I am confident that I can solve problems by selecting and processing information.
Student as a Quality Producer	• Someone else sets the standards and I try to create a product to meet them.	• I may need help understanding what makes a good product, and support to create it.	• I compare my work to models and use them as an example for my product.	• I hold high standards for my work and create quality products.
Student as a Self-Directed Learner	• I have trouble choosing my own resources and I like someone to tell me the a nswer.	• I might know what I want, but need to ask for help in solving information problems.	• I choose my own resources and like being independent in my information searches.	• I like to choose my own information resources. I am comfortable in situations where there are multiple answers as well as those with no answers.
Student as a Group Contributor	• I need support to work in a group. I have trouble taking responsibility to help the group.	• I usually participate with the group. I offer opinions and ideas, but can not always defend them. I rely on others to make group decisions.	• I participate effectively as a group member. I help the group process, and evaluate and use information with the group.	• I am comfortable leading, facilitating, negotiating, or participating in a group. I work with others to create a product that fairly represents consensus of the group.
Student as a Responsible Information User	• If I find information I can use I copy it directly. I need to be reminded about being polite and about sharing resources and equipment with ot hers.	• I usually remember to give credit when I use someone else's ideas. It is okay for others to have different ideas from mine. I try to be polite and share information resources and equipment with ot hers.	• I do not plagiarize. I understand the concept of intellectual freedom. I am polite and share resources and equipment with others.	• I follow copyright laws and guidelines. I help others understand the concept of intellectual freedom, and can defend my rights if challenged. I acknowledge and respect the rights of others to use information resources and equipment.

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6. The instructorshould serve as a facilitator of learning rather than as a font of knowledge or expertise. This guarantees that participants will find the trainer approachable, an absolute precondition of communication between adult learner and teacher.

Perhaps the single most important idea is that adults want instruction to be relevant to their needs and concerns and at a level that is appropriate to their needs.

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Stages of Concern and Levels of Knowledge

There has been quite a bit of professional development research focusing on Stages of Concern (Hall, 1974). An educator who knows very little about information technology has different concerns and professional-development needs than an educator who has been making personal use of computers and other information technologies for several years.

Professional development is more effective if it specifically addresses the concerns of the educators and builds on their current levels of knowledge and use. This is one reason to emphasize one-on-one inservice and teachers learning alongside their students. In both of these professional-development approaches, the learning opportunity can be carefully tuned to the stage of concern and level of knowledge of the learner.

The various Stages of Concerns and Levels of Knowledge (SC&LK) that teachers have about the information technologies are not easily grouped into simple categories. However, the following list is indicative of the range of possible situations. It is a Stages of Concern model that has been adapted specifically to microcomputers and other information technologies such as CD-ROMs, networking, digital cameras, and scanners.

1. Awareness: I have an awareness of microcomputers and other information technologies, but I do not make professional use of them. I do not engage my class in discussions about information technologies even when I realize that this would be relevant to the topic at hand. I am somewhat technophobic.

2. Informational: I have a novice level of microcomputer and other information technology knowledge and skill. Although I sometimes make personal use of these facilities, my level of knowledge is not adequate for professional use. I am concerned about gaining more general information about their potential uses in my professional work.

3. Personal: I am beginning to make use of microcomputers and other information technologies in my professional work. I am concerned about how using this technology will affect me personally in my professional career as an educator.

4. Time: I am concerned about the time needed to learn about and keep up with the rapid changes in the information technologies in education. As I continue to learn, I sometimes feel overwhelmed by how much there is to learn and how much time it takes to keep up.

5. Consequences: I make quite a bit of use information technologies in my professional work. I am concerned about the effects my use of microcomputers, networking, and other information technologies are having and should be having on my students and on my professional work.

6. Collaboration: I occasionally help a colleague to handle an information technology hardware or software problem in an informal, one-on-one setting. I am concerned about doing more extensive work with my peers so that we can all learn more about information technologies in education.

7. Refocusing: I am comfortable making routine professional use of information technologies and helping my colleagues to learn. I am concerned about learning new ways to use what I already know and about expanding my horizons.

8. Leadership: I am a technology leader and high-level facilitator. I am concerned about continuing to maintain and improve my leadership and professional-development skills in my school, school district, and beyond.

This scale can be used to do a needs assessment in a school or school district. Teachers who are at the higher levels can help others determine where they fit and then help their colleagues to move up the scale. A faculty can assess all of its teachers, and do a scatter plot of the resulting distribution. The professional-development goals of the school might be to help each individual teacher move up the scale and to produce a cadre of teachers at level 6 or higher.

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Risk-taking Early Adopters

The following are some questions to ask yourself and to use in needs assessment:

- When it comes to information technologies in education, am I a risk taker?
- Am I an early user of new software and hardware?
- Is my level of classroom implementation usually somewhat beyond my knowledge and comfort levels?
- Do I frequently learn alongside my students?"

If most of your answers are "yes," you fall into a category known as "early adopters." A person who responds "no" to most of these questions will probably prove to be a late adopter.

For any new educational innovation that is eventually widely adopted, there are early adopters (perhaps 5%-10%), a large middle group that takes much longer to adopt the innovation (perhaps 80%-90%), and the laggards or late adopters (perhaps 5%-10%). The early adopters tend to push the information-technology instructional envelope. They frequently bring other teachers along with them--indeed, a few early adopters can sometimes change an entire school.

The SC&LK model partially represents actual classroom implementation of information-technology knowledge. However, educators may practice at a level quite a bit above or below what one might expect from their placement on the SC&LK scale.

LabNet is a vibrant and growing electronic community for primary and secondary science and math teachers who aim to implement the new standards for math and science with inquiry-oriented. project-based learning. It provides a meeting place for teachers to support each other in experimenting with new teaching strategies. reflect on their teaching experiences. problem solve. share resources. and build collegial connections with their peers.

"The LabNet telecommunication network connects more than 1,500 participating teachers from all 50 states. *Message boards* (where members can initiate and carry on extended. public dialogues), *file libraries* (with science materials and project database). on-line *chat areas* (for real-time conferencing). and a private *e-mail system* (which supports an Internet gateway and easy computer-computer transfer of many kinds of files) provide the structure for teacher-teacher communications. Teacher-moderators weave together strands of teacher contributions and help to link reflection on the network with action in the classroom." (Spitzer et al.. 1994)

"Montana supports connections between its 15 regional training centers with a telecommunications network, the Montana Educational Technology Network (METNET). METNET uses bulletin board systems that feature curriculum guides, lesson plans, and cooperative learning projects to facilitate the sharing of teaching resources among the centers." (OTA, 1995)

Networks can also provide support for professional partnerships between schools and outside organizations. For example, the California Technology Project supports free K-12 telecommunications and preservice teacher links (OTA, 1995). At the University of Illinois, Jim Levin and Michael Waugh work on a number of levels to link teacher education with school practice; see boxed text below.

In the Teaching Teleapprenticeships models, developed at the University of Illinois, teacher education students and practicing teachers learn about teaching and learning by participating in electronic network-based activities with K-12 students, teachers and administrators, and university-based teacher educators. Teachers' resources are extended beyond the traditional face-to-face interactions, through network interactions and resource sharing.

During the years before their fieldwork in their senior year, preservice teachers are introduced to the Internet through pre-apprenticeship exercises which link K-12 classrooms to their other coursework (e.g., for a university course in biology, researching and responding to K-12 students' questions about leaf structure).

When they begin their field work, student teachers are then prepared to share their beginning knowledge of using the network with master teachers, and to introduce network-based activities in the classroom. Levin notes, "Some of our cooperating teachers mention that teleapprenticeships are kind of funny because they imply that someone is the apprentice and someone is the master. The master teachers are finding that it sometimes works both ways with their student teachers. They, of course, are the masters in how to teach, but they are often the beginners on how to use telecommunications (Levin, in Weakland, 1994).

"The university conducts a well-attended continuing education course on the use of electronic networks in education for practicing K-12 teachers, and is also working to institute a statewide K-12 network so that graduating students who go on to teach in the state can continue to have access to the Internet." (Levin, 1990; Weakland, 1994)

Rethinking

How to Invest in Technology

With "distributed learning" and reconfigured budgets, school districts can transform technological innovations into universal improvements in education in a way that is both affordable and sustainable.

Chris Dede

As the articles in this issue of *Educational Leadership* document, new technology-based models of teaching and learning have the power to dramatically improve educational outcomes. An important question is, How can districts scale up scattered, successful "islands of innovation" into universal improvements in schooling?

Such improvements can take place only within the larger context of systemic reform—sustained, large-scale, simultaneous innovations in curriculum, pedagogy, assessment,

professional development, administration, incentives, and partnerships for learning among schools, businesses, homes, and community settings. Systemic reform requires policies and practices different from fostering pilot projects for small-scale educational improvement. As it relates to technology-based improvements in education, systemic reform involves at least two major shifts: (1) rethinking the organization of learning to include the possibility of "distributed learning"—the use of information technologies outside the school setting to enhance classroom activities; and (2) moving from using special, external resources to reconfiguring existing budgets to free up money for innovation. Before undertaking these shifts, however, schools should consider some underlying concerns.

Moving Beyond Naive Conceptions

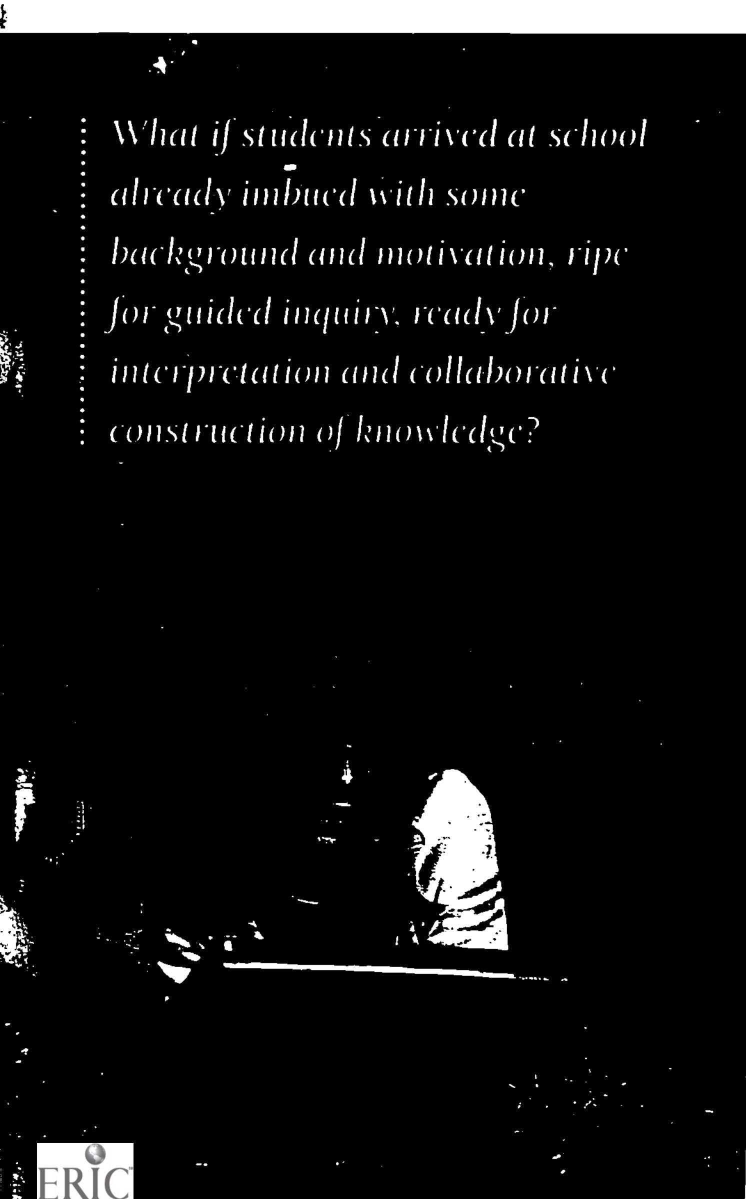
Giving all students continuous access to computers with Internet connections and multimedia capabilities is currently quite fashionable. For politicians, the Internet in every classroom has become the modern equivalent of the promised "chicken in every pot." Communities are urging volunteers to participate in "Net Days" to wire the schools. Information technology vendors are offering special programs to encourage massive educational purchases. States are setting aside substantial amounts of money for building information infrastructures dedicated to instructional usage.

As an educational technologist, I am more dismayed than delighted by how this enthusiasm about the Internet is being expressed. Some of my nervousness comes from the "first-generation" thinking about information technology that underlies these visions. Many people see multimedia-capable, Internet-connected computers as magical devices, silver bullets to solve the problems of schools. They assume that teachers and administrators who use new media are automatically more effective than those who do not. They envision classroom computers as a technology comparable to fire: Students benefit just by sitting near these devices, as knowledge and skills radiate from the monitors into their minds.

Yet decades of experience with technological innovations based on first-generation thinking have demonstrated that this viewpoint is misguided. Unless other simultaneous innovations occur in pedagogy, curriculum, assessment, and school organization, the time and effort expended on instructional technology produce few improvements in educational outcomes—a result that reinforces many educators' cynicism about fads based on magical machines.

Additional concerns about attempts to supply every student with continuous access to high-performance computing and communications technology relate to the likely cost of this massive investment. Depending on the assumptions made about the technological capabilities involved, estimates of the financial resources needed for such an information infrastructure vary (Coley et al. 1997). Extrapolating the most detailed cost model (McKinsey and Company 1995) to one multimedia-capable, Internet-connected computer for every two to three students yields a price tag of about $94 billion of initial investment and $28 billion per year in ongoing costs—a financial commitment that would drain schools of all discretionary funding for at least a decade.

For several reasons, this is an impractical approach for improving education. First, putting this money into computers and cables is too large an investment in just one part of the infrastructure improvements that many schools desperately need. Buildings are falling apart, furnishings are dilapidated, playgrounds are in disrepair. If these needs are ignored, the machines will cease to function, as their surroundings deteriorate. Also, educational researchers and developers need substantial funding for other types of innovations required to make instructional hardware effective, such as standards-based curricular materials for the World Wide Web and alternative kinds of pedagogy that link teachers and tools. (The McKinsey cost estimates do include some funding for content development and staff training, but in my judgment it is too little to enable effective technology integration and systemic reform.)



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Second, without substantial and extended professional development in the innovative models of teaching and learning that instructional technology makes possible, many educators will not use these devices to their full potential. "Second-generation" thinking in educational technology does not see computers as magical, but it does make the mistake of focusing on automation as their fundamental purpose. It envisions computers as empowering "teaching by telling" and "learning by listening." In this view, the computer serves only as a fire hose that sprays information from the Internet into learners' minds. Even without educational technology, classrooms are already drowning in data. Adding additional information, even with multimedia bells and whistles, is likely to worsen rather than improve educational settings. Professional development needs are more complex than increasing educators' technical literacy (training in how to use Web browsers, for example). They involve building teachers' knowledge and skills in alternative types of pedagogy and content. Such an increase in human capabilities requires substantial funding that will be unavailable if almost all resources are put into hardware.

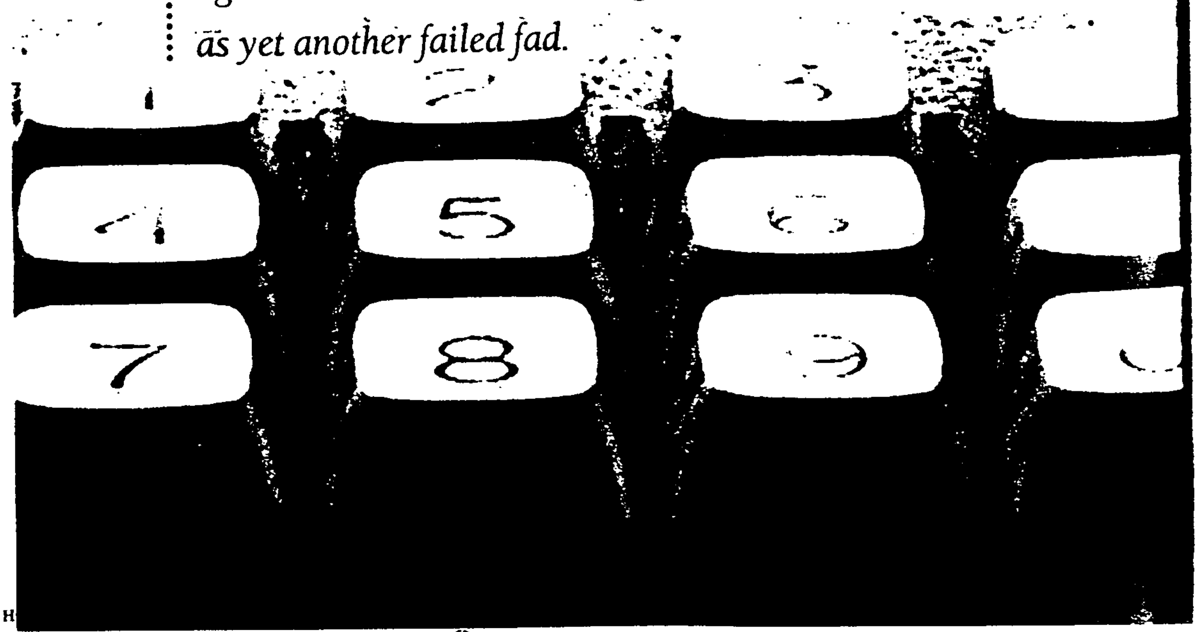
Third, the continuing costs of maintaining and upgrading a massive infusion of school-based technology are prohibitive. High-performance computing and communications systems require high-tech skills to remain operational, and, moreover, they will become obsolete in five to seven years as information technology continues its rapid advance. Taxpayers now see computers as similar to chalkboards: Buy them once, and they are inexpensively in place for the lifetime of the school. School boards quickly become restive at sizable yearly expenditures for technology maintenance and usage—especially if, several months after installation, standardized test scores have (unsurprisingly) not yet dramatically risen—and they will become apoplectic if the replacement of obsolete equipment consumes additional substantial sums only a few years after a huge initial expenditure. For all these reasons, investing an exorbitant amount in information infrastructures for schools is impractical and invites a later backlash against educational technology as yet another failed fad.

I would go further, however, and argue that we should not make such an investment even if a technology fairy were to leave billions under our virtual pillows, no strings attached. Kids continuously working on machines with teachers wandering around coaching the confused is the wrong model for the classroom of the future. In that situation—just as in classrooms with no technology—too much instructional activity tends to center on presentation and motivation, building a foundation of ideas and skills as well as some context that helps students understand why they should care about learning the material. Yet this temporary interest and readiness to master curricular material rapidly fade when no time is left for reflection and application, as teachers and students move on to the next required topic in the overcrowded curriculum, desperately trying to meet all the standards and prepare for the tests.

Investing an exorbitant amount in information infrastructures for schools invites a later backlash against educational technology as yet another failed fad.

Helping students make sense out of something they have assimilated but do not yet understand is crucial for inducing learning that is retained and generalized, much research documents (Schank and Jona 1991). Learners must engage in reflective discussion of shared experiences from multiple perspectives if they are to convert information into knowledge and master the collaborative creation of meaning and purpose (Edelson et al. 1996).

But what if much of the presentation and motivation that is foundational for learning occurred outside of classroom settings, via information technologies that are part of home and workplace and community contexts? What if students arrived at school already imbued with some background and motivation, ripe for guided inquiry, ready for interpretation and collaborative construction of knowledge? By diverting from classroom settings some of the burden of presenting material and inducing motivation, learning activities that use the technology infrastructure outside of schools would reduce the amount of money needed for adequate levels of classroom-based technology.



Such a strategy also would enable teachers to focus on students' interpretation and expressive articulation without feeling obligated to use technology in every step of the process.

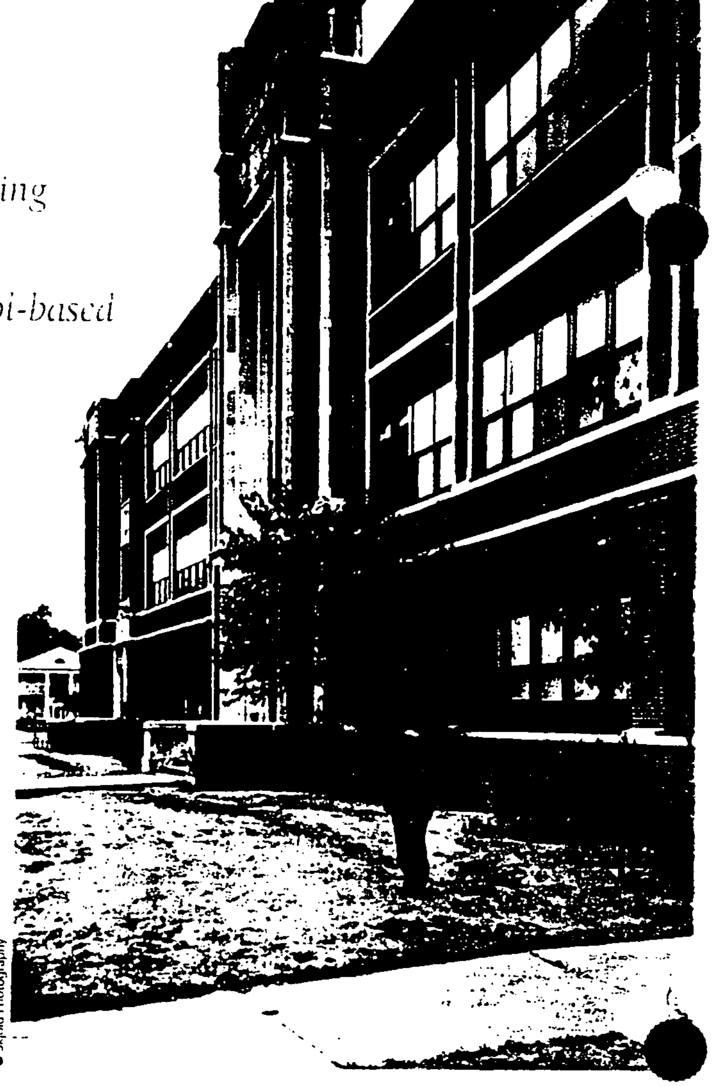
Putting Distributed Learning to Work

Distributed learning involves orchestrating educational activities among classrooms, workplaces, homes, and community settings (Dede 1996). This pedagogical strategy models for students that learning is a part of all aspects of life—not just schooling—and that people adept at learning use many types of information tools scattered throughout our everyday context. Such an educational approach can also build partnerships for learning between teachers and families, activating a powerful lever for increasing student performance.

A district that exemplifies this model of distributed learning is Union City, New Jersey. This district emphasizes integrating Internet resources into the curriculum, as well as giving students skills in authoring techniques and design principles for building World Wide Web resources. As part of the learning process, students create Web sites that provide information about various local government agencies and social service organizations, including the public housing authority, the mayor's office, and a day-care provider. The school district also sponsors a Parent University to facilitate parental involvement. Parent University's evening learning experiences in schools help families and taxpayers understand investments in educational technology as one vital part of the district's extensive educational reform process. The Parent University partnerships are reinforced by electronic newsletters, by computers in public libraries used to teach basic skills to adults, and by School Improvement Teams that give participants a voice in shaping schools' policies and innovations.

A partnership between Bell Atlantic–New Jersey and the school district has aided the district's efforts by expanding the community's telecommunications connections. Among other things, the partnership has provided students and teachers with computers at both home and school to link the two learning environments and allow communication via e-mail. In addition, technology-based instructional materials funded by the National Science Foundation that emphasize student inquiry projects in community settings also are helping educational reform in Union City. Locally developed Web-based curriculums also address the specific needs of this urban, ethnically diverse, low-income locality.

Community learning environments can complement school-based technology.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The district has dramatically improved its student learning outcomes through this model of distributed learning. Specific outcomes include significantly higher standardized test scores, improved writing and research skills, and decreased absenteeism.[1]

Even without a sophisticated infrastructure, readily accessible new media can facilitate large-scale educational innovation. People are spending lots of money on devices purchased for entertainment and information services: televisions, videotape players, computers, Web TV, videogames. Many of the underlying technologies are astonishingly powerful and inexpensive: The Nintendo 64 machine available now for a couple hundred dollars is the equivalent of a graphics supercomputer that cost several hundred thousand dollars a decade ago. What if these devices—many of them common in rich and poor homes, urban and rural areas—were also used for educational purposes? For example, videogame players are widely available in poor households and provide a sophisticated but inexpensive computational platform for learning—if we develop better content than the mindless material that constitutes most videogames. My research in virtual reality illustrates how multisensory, immersive virtual environments could be used to help students learn complex scientific concepts on computational platforms as commonplace as the videogames of the next decade.[2]

Districts can leverage their scarce resources for innovation, as well as implement more effective educational models, by using information devices outside of classrooms to create learning environments that complement school-based technology. The question remains, however: How can schools afford enough computer and telecommunications technology to sustain new models of teaching and learning and curriculum essential for systemic reform?

Finding the Dollars

In the past, money for technology improvements has come largely from special external sources: grants, community donations, bond initiatives. To be sustainable over the long run, however, resources for technology must come from reallocating existing budgets by reducing other types of expenditures. Of course, those groups whose resources are cut resist such shifts in financing, and district administrators and school boards have been reluctant to take on the political challenges of changing how money is spent. An easy way to kill educational innovations is to declare that of course they will be implemented—as long as no existing activities must be curtailed to fund new approaches.

Educational organizations are unique in demanding that technology implementation be accomplished via add-on funding.

Educational organizations are unique, however, in demanding that technology implementation be accomplished via add-on funding. Other institutions—factories, hospitals, retail outlets, and banks, for example—recognize that the power of information devices stems in part from their ability to reconfigure employee roles and organizational functioning. These establishments use the power of technology to alter their standard practices, so that the cost of computers and communications is funded by improvements in effectiveness within the organization, by doing more with less. If educators were to adopt this model—reallocating existing resources to fund technology implementation—what types of expenditures would drop so that existing funds could cover the costs of computers and communications?

Visions presented in the forthcoming 1998 ASCD yearbook (Dede and Palumbo, in press) depict how altered configurations of human resources, instructional modalities, and organizational structures could result in greater effectiveness for comparable costs—even with the acquisition of substantial school-based technology. This case is also made at greater length in Riel (1995) and in Hunter and Goldberg (1995). One specific example would involve a reordering of roles. Currently teachers all have comparable roles with similar pay structures—unlike other societal organizations, which have complementary staff roles with a mix of skill levels and salaries.

In the commercial sector, these types of institutional shifts too often result in layoffs. Because of the coming wave of retirements among educators, however, districts have a window of opportunity to accomplish structural changes without major adverse impacts on employees. As large numbers of baby boom educators leave the profession, a concurrent process of organizational restructuring could occur. Coordinating technology expenditures as an integral part of that larger framework for institutional evolution is vital as districts plan for the future. Using technology to implement new types of content and pedagogy attracts a new generation of teachers with a broad range of skills and knowledge that instructional media can complement.

Thinking Differently

Technology-based systemic reform is hard in part because our ways of thinking about implementation are often flawed. Large-scale educational innovation will never be easy, but it can be less difficult if we go beyond our implicit assumptions about teaching, learning, technology, schooling, and society. The conceptual framework of distributed learning, coupled with reconfigured budgets, is not a blueprint for universal educational improvement based on information technology—no one yet has such a recipe—but it is a vision that is affordable, generalizable, and sustainable. By balancing investments in advanced technology with investments in sophisticated curriculum, assessments, and eduators—in and out of school—we can successfully prepare children for the tremendous challenges of the 21st century. ■

[1]Readers can view the city's Web site (www.union-city.k12.nj.us) for further information.

[2]For more information, see the Web site for Project ScienceSpace (http://www.virtual.gmu.edu).

References

Coley, R.J., J. Cradler, and P.K. Engel. (1997). *Computers and Classrooms: The Status of Technology in U.S. Schools.* Princeton, N.J.: Educational Testing Service.

Dede, C. (1996). "Emerging Technologies and Distributed Learning." *American Journal of Distance Education* 10, 2: 4-36.

Dede, C., and D. Palumbo, eds. (in press). *Learning with Technology.* The 1998 ASCD Yearbook. Alexandria, Va.: ASCD.

Edelson, D.C., R.D. Pea, and L.M. Gomez. (1996). "Constructivism in the Collaboratory." In *Constructivist Learning Environments: Case Studies in Instructional Design,* edited by B. Wilson. Englewood Cliffs, N.J.: Educational Technology Publications.

Hunter, B., and B. Goldberg. (1995). "Learning and Teaching in 2004: The BIG DIG." In *Education and Technology: Future Visions* (OTA-BP-EHR-169), edited by the Office of Technology Assessment. Washington, D.C.: U.S. Government Printing Office.

McKinsey and Company. (1995). *Connecting K-12 Schools to the Information Superhighway.* Palo Alto, Calif.: McKinsey and Company.

Riel, M. (1995). "The Future of Teaching." In *Education and Technology: Future Visions* (OTA-BP-EHR-169), edited by the Office of Technology Assessment. Washington, D.C.: U.S. Government Printing Office.

Schank, R.C., and M.Y. Jona. (1991). "Empowering the Student: New Perspectives on the Design of Teaching Systems." *The Journal of Learning Sciences* 1, 1: 7-35.

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DESIGNING FOR THE FUTURE

By Daniel T. Cincoski, RCDD

When it comes to educational technology, the best advice is to plan for change

Talking about technology for school districts means discussing a moving target, a topic that changes according to what constitutes state-of-the-art for each district and each district's opinion of the importance of technology. One district might have all the latest and greatest in video, voice, and data systems, including staff development and ongoing upgrades, while another district is at the other end of the spectrum and still others fall somewhere in between.

Virtually all school districts have made some commitment to technology for administrative uses and for curriculum and instruction. The commitment varies from district to district, however, because of the costs of installation, the extent of the systems and equipment each district installs, and the district's ongoing staff development and upgrades. Many districts have committed funding for technology, but most have been able to take only the initial steps of readying the infrastructure and acquiring a limited version of the desired systems.

In many districts, for example, including technology has meant converting one classroom to a computer lab, adding power, rearranging the desks, wiring a print-sharing network, and possibly adding air-conditioning. Even today, if you walk into a school and ask, "Show me your technology," the typical response is usually a tour of the school's computer lab. But in actuality the whole school should be the computer lab.

In the past, teaching technology was a drill-and-practice routine as the student learned how to use a computer. Today, students are using technology as a tool for learning, which requires teachers to become facilitators and to be proficient in voice, data, and video technology. The old routine has given way to new teaching and learning methodologies, complete with a new vocabulary: networking, file servers, hubs and routers, multimedia, Internet access, media retrieval, distance learning, interactive video, virtual reality, satellite TV, cable TV, fiber optics, microwave, Category 5 data cable, CD ROMs.

In today's global society, the question is no longer, "Why do we need to teach kids technology?" Perhaps better questions are, "How much technology is needed? And how can a district be sure its schools are designed for technology?"

The power of technology

Designing for technology involves the school's physical structure as it relates to the educational philosophy of instruction and cur-

CINCOSKI, 1996

Independent learning center serving two classrooms, Maple Grove High School, Osseo Public Schools, ISD No. 279, Osseo, Minn.

Allan Elementary School, TX
Allegheny Comm. College, PA
Allison Elementary School, TX
Andrews Elem. School, TX
Atkinson Hall, Hampden-Sydney College, VA
Atlantic High School, IA
Austin Comm. College - Northridge, TX
Austin Comm. College - Riverside, TX
Bailey Junior High School, TX
Balaclava Public Sch., Ontario
Baltimore Elementary, Ontario
Bard College, NY
Barnegat Middle School, NJ
Barrington Elementary, TX
Barton Hills Elementary, TX
Bayridge North Elementary, Ontario
Becker Elementary School, TX
Bedichek Middle School, TX
Big Park Comm. School, AZ
Blanton Elementary School, TX
Boone Elementary School, TX
Bowie Elementary School, TX
Branson Elementary, MO
Branson Middle School, MO
Brenton Cty. S. Elementary, MO
Brentwood Elementary, TX
Brewster School District Elem. School, WA
Brewster School District H.S., WA
Brooke Elementary School, TX
Brown Elementary School, TX
Bryker Woods Elementary, TX
Burland School, Manitoba
Butterfield School, MO
Cameron Middle School, MO
Camp Dick Robinson Elementary School, KY
Campbell Elementary, TX
Cardinal Carter Secondary School, Ontario
Carleton University, Ontario
Casey County High School, KY
Casper College #1, WY
Casper College #2, WY
Center School, TX
Central Valley School, ND
Chelsea School, NJ
Christ the King Catholic School, Ontario
Christian County H.S., KY
Churchill Public School, Ontario
Claremore Elementary, OK
Clark School, NJ
Collings Lakes Elementary, NJ
Columbia College, MO
Copper Hill Elementary, NJ
Cromwell High School, MN
Cunningham Elementary, TX
Dallas County School, MO
D'Angelo Sch. of Music, Mercyhurst College, PA
Daniel Boone High School, TN
Daviess County High, KY
Davis Elementary School, TX
Dawson Elementary, TX
Douglass School, NJ
Eaglewood Elementary, NJ
East Carter County High, KY
Ecole Catholique Marie Curie, Ontario
Ecole Pointe La Chene, Manitoba
Ecole Professionnelle du St. Hyacinthe, Quebec
Eisenhower Elementary, NJ
Ely Community College, NV
Ernest Cumberland Elementary, Ontario
Excelsior Spgs. Mid. School, MO
F.R. Rice Elementary, TX
Fargo Middle School, ND
Father Gerald Labelle School, Ontario
Father Michael McGivney School, Ontario
Fenelon Falls School, Ontario
Frontenac County Elementary School, Ontario
Fulmore Middle School, TX
Fuqua Private School, VA
Gallatin County H.S., KY
Georgian College, Ontario
Georgian College, Ontario
Glen Abbey Public School, Ontario
Gloucester County College, NJ
Gloucester County Library, NJ
Good Shepherd Elem., Ontario
Goodnight Jr. High School, TX
Govalle Elementary School, TX
Graham Elementary, TX
Great Bridge Middle School South, VA
Gull Island Secondary, BC
Gullett Elementary School, TX
H.J Alexander Elementary School, Ontario
Harris Elementary School, TX
Haskell Institute, KS
Hastings School, MA
Heart of the Lakes School, MN
Hespeler East Public School, Ontario
Hickory County School, MO
Highland Park Elementary, TX
Hill Elementary School, TX
Hollister School, MO
Holy Family School, Ontario
Hopkinsville High School, KY
Houston Elementary, TX
Hurley School, MO
Iona High School, Ontario
Issaquah School District, WA
J.F. Kennedy School, NJ
Janet Lee Public School, Ontario
John Forsythe School, Manitoba
Jordon Elementary School, TX
Josephine Houston Elem., TX
Joslin Elementary School, TX
Junction City School, OR
Kiker Elementary School, TX
Kinder Elementary, Ontario
Kirkcaldy, Manitoba
Kirkfield Public School, Ontario
Kittitas Middle School, WA
KMS Public School, MN
Kocurek Elementary, TX
Lady Meredith House, Quebec
Lake City High School, ID
Lakeland Elementary, MO
Lee Elementary School, TX
Lt. of Christ Elem., Ontario
Lincoln Hancock Elem., MA
Linder Elementary School, TX
Linn Technical College, MO
Linn Technical College - Aviation Bldg. MO
Manchaca Elementary, TX
Maplewood Elementary, TX
Marsing High School, ID
Martin Middle School, TX
Mathews Elementary, TX
Maywood Elementary, IN
McKee Elementary School, KY
McLean Middle School, KY
Meadowlark Elementary, NE
Meadows West, Manitoba
Metz Elementary School, TX
Middletown High School, DE
Mitchell School, Manitoba
Monett High School, MO
Neff Elementary School, PA
Neff High School, PA
New Egypt Middle School, NJ
Nixa Elementary School, MO
Norman Elementary, TX
North Main Elementary, NJ
North Royalton Mid. School, OH
O Henry Middle School, TX
Oak Hill Elementary, TX
Oak Hill Elementary, KY
Oak Ridges Catholic School, Ontario
Oak Springs Elementary, TX
Ocola Phase II School, OK
Odom Elementary School, TX
Olso Ocedo School
Onamia Elementary, MN
Orchard Park School - Admin, Ontario
Ortega Elementary School, TX
Osage Beach School, MO
Osceola Public School, MO
Otsego Elementary School, MN
Pacific Junction School, Manitoba
Paint Lick Elementary, KY
Patton Elementary School, TX
Patuxent River NAS Bldg. 2189, MD
Pease Elementary School, TX
Pecan Springs Elementary, TX
Pembroke Elementary, KY
Perham Elementary, MN
Philip Pocock Secondary School, Ontario
Pillow Elementary School, TX
Plainville Public School, Ontario
Pleasantville High School, NJ
Pleasantville Middle School, NJ
Plumstead Middle School, NJ
Porter Middle School, TX
Prince Charles School, Ontario
Prince of Peace Elementary School, Ontario
Red Bank Primary School, NJ
Redly Elementary School, TX
Rice Elementary School, TX
Ridgetop Elementary, TX
Ridgeview Elementary, OR
Rio Grande Special Use Campus, TX
River Oaks Public School, Ontario
Robert F. Hall Secondary, Ontario
Rock Springs School, NC
Rosedale Center Elem., TX
Russell O. Brackman Middle School, NJ
Sacred Heart Catholic School, Ontario
Salem Community College, NJ
Salem Elementary School, AR
Salem High School, AR
Sanchez Elementary, TX
Schuyler Elementary, MO
Scott County High School, KY
Seventh Grade Center, OK
Sims Elementary School, TX
Six Nations School C' Ohsweken, Ontario
Southeast Elementary, IA
Southern Reg. Admin., NJ
Spencer County Elem., KY
Spotswood Board of Education, NJ
St. Augustine Secondary School, Ontario
St. Clair Intermediate School, MI
St. David's School, Ontario
St. Elmo Elementary, TX
St. Johns Catholic Educational Center, MN
St. Johns School, TX
St. John's School, TX
St. Joseph's Elementary, Ontario
St. Jude Catholic, Ontario
St. Mark Elementary, Ontario
St. Monica Elementary, Ontario
St. Nicholas Catholic, Ontario
St. Patricks H.S., Ontario
St. Paul's Roman Catholic School, Ontario
St. Therese Elementary, Ontario
St. Thomas O'Aquin Elementary, Ontario
Stewartsville Elementary, NJ
Stockton State College, NJ
Summit Elementary, TX
Sunrise Middle School, NE
Taylor Elementary School, VA
Tebrik Catholic School, Ontario
The David School, KY
Trailridge Elementary, MO
Trailwoods Environmental Science, K.C., MO
Travis Heights Elementary, TX
Trenton High School, Ontario
Upper Perkiomen H.S., PA
Upper Township Middle School, NJ
Val Gagne R.C.S.S., Ontario
Van Wellegham School, Manitoba
Varney Elementary School, KY
Veterans Park Elementary, KY
Wahpeton Middle School, ND
Walnut Creek Elementary, TX
Warsaw Elementary, MO
Wattsburg Elementary, PA
Webb Middle School, TX
Wellsville Elementary, MO
West Bertie County Elementary, NC
West Carter County H.S., KY
Weston Downs #2 Catholic School, Ontario
Westwood Comm. School, IA
White Pine County H.S., NV
White Pine County School, NV
Whitesville Elementary, KY
Widen Elementary, TX
Willard Elementary, MO
Williams Elementary, TX
Windber Elementary, PA
Winn Elementary School, TX
Winner Elementary School, SD
Winner Middle School, SD
Woodlands Skill Center, MI
Wooten Elementary School, TX
York - Humber High School, Ontario
Yreka Union High School, CA
Zilker Elementary School, TX

If your school should be on this list and is not, please contact GHPC at 1-888-333-4472.

GEOTHERMAL HEAT PUMP CONSORTIUM

riculum. The physical structure includes proper spaces for infrastructure, electronic equipment storage closets, and communications room.

Instructional needs include proper space, lighting, and environment and the equipment within the classroom or lab; and curriculum needs include such facilities as the TV studio as a learning lab.

Voice, data and video technologies enhance the curriculum and become tools for teaching and learning in many ways:

■ **Technology empowers advanced thinking**—mathematical processes, multiple resources and viewpoints.
■ **Technology expands access to resources**—electronic libraries, e-mail, the World Wide Web, telecommunications, video on-demand.
■ **Technology documents and transports**—information, images, news, events.
■ **Technology provides virtual reality experiences**—tech-prep, science, art, graphics, TV productions, CAD/CAM.
■ **Technology provides remote access**—distance learning, robotic investigation, interactive distant exploration.
■ **Technology provides simulation**—science, travel, operational equipment.

Historically, school districts have also used technology for administrative purposes, and new technologies have expanded their capabilities. Technology enhances a school district's business administration by handling correspondence, finance, communication, information distribution, employee records, payroll, and reporting. And technology streamlines school administration tasks such as enrollment, attendance, scheduling, and grading.

A master plan

Designing for technology begins with a master plan that defines the district's mission and vision and identifies its main objectives. This master plan should reinforce and enhance the district's educational philosophy. It should describe the tools that enable the district to enhance the learning experience for students and improve the efficiency of administration. It should lay the groundwork for future advances and allow for ongoing growth, change, and obsolescence.

The master plan should also identify the ongoing staffing levels and costs required to maintain and operate the systems and to train others. It should identify the necessary budget for annual upgrading of obsolete software and equipment. More often than not, most districts are understaffed, and one person tries to do the work of five people. The educational community could learn from the business community and develop a solid plan for technology that includes budgeting for upgrades and operating costs; buildings with integrated infrastructure; room for change, growth, and adoption; and a staff support system for operations, maintenance, training, and support.

A successful master plan must have the support of the administration, staff, students, and community. Teachers must receive proper training in the use of the new technologies before they can successfully teach and facilitate the learning processes. In

fact, districts that have used technology for any length of time have found that staff development must be continuous.

The master plan must identify the ongoing operating costs for the new technologies, which include:

■ **Telephone service:** monthly costs for analog and digital dial-tone.

■ **Cable service:** monthly access costs, if any.

■ **Internet connection and access:** fees based on bandwidth and network features.

■ **District wide-area network (WAN):** leased telecommunication lines or cable TV service.

The costs for these services will be affected by the region of the country in which the district is located and the discount rates established in rulings that are expected in the spring of 1997 as a result of the Telecommunications Act of 1996.

The plan should also specify tools for technology, which can be categorized into four areas, each with a different life expectancy:

■ **Applications:** computer software, videotapes, and discs—one to 2 years.

■ **Equipment:** video equipment, computers, and peripheral equipment—three to 10 years.

■ **Systems:** telephone, video headends, computer network hubs and servers, data access services—four to 10 years.

■ **Infrastructure:** communications rooms and closets, pathways and cable trays, conduits and outlets, power, lighting and environmental controls—25 to 50 years, or the life of the building.

DAN LIMOSKI 1996

Data and voice systems

To most people "school technology" means computers, first and foremost. And in fact, school computer use has expanded from separate computer lab to classrooms, staff areas, media centers, and independent learning areas, making computers accessible to students and teachers alike throughout the day. Computer labs on carts are replacing fixed labs, and small notebook computers are supplementing or replacing larger models. In some schools, teachers use notebook computers that can be connected to the school network in a classroom or staff office, and students are being given notebook computers in ninth grade to carry until graduation. Students who graduate are given the computer; those who don't must pay for the computer or turn it back in.

Local-area network systems (LANS) have to accommodate such changes. Wired connections continue to serve key locations, while portable-distribution electronics expands connectivity into learning spaces and wireless LANS connect notebook computers. Standards for wireless networking are being written by the Institute of Electrical and Electronic Engineers, Inc., and should be available this spring. These standards will help lower prices and allow growth in size and speeds of networking. Wired networks will continue to play an important role for high-speed networking and for providing the backbone to wireless technology.

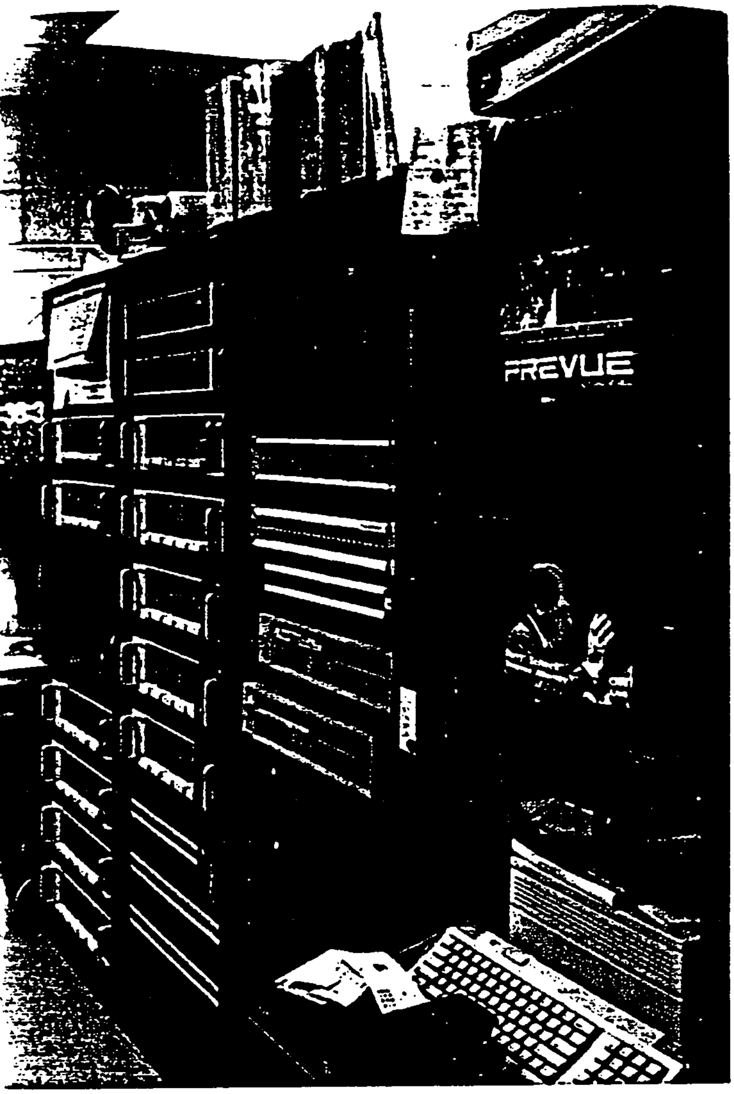
The latest trend in classroom computer networking is using the Internet, a worldwide "network of networks" that has been around for some 20 years. The Internet's ticket to popularity is the World Wide Web, with its graphics-based hyperlinks that make searches intuitive. The immediacy of Internet e-mail provides for around-the-world access to students, friends, acquaintances, and resources. But the Internet's popularity has led to some problems, including slow access speed and traffic jams that interrupt access and cause disconnections from Internet servers. The Internet and similar services will continue to grow in speed and accessability as demand for better services forces Internet providers to meet customer demand. Other problems are security and the possibility that students will access inappropriate, sometimes dangerous content; these maladies require equipment and usage policies to protect computers from viruses and discourage inappropriate use.

Voice systems are another important technology. Telephones in classrooms serve both traditional and high-tech functions—as school intercoms, emergency communications, the teacher's business telephone, and the instructional telephone. Compared with computer and video communications, the telephone is an inexpensive link for accessing other classrooms, schools, homes, the community, and beyond.

Voice mail—preferably one large voice-mail system connected to all district facilities through a networked telephone system—improves communications between administrators and teachers and between teachers and parents, and unlike e-mail, it does not require special equipment in the home.

Video systems

"Moving pictures" have been recognized as an effective instruc-



Video headend and work room. Champlin Park High School. Anoka/Hennepin Public Schools. ISD No. 11, Anoka. Minn.

tional device since the 16 mm film of the 1950s, now replaced by videotape and videodisc. When classrooms lost the large projected image of 16 mm to 25-inch TVs with VCRs on carts, they gained portability and reliability. Cable TV brought further advances. Current video systems provide three major services: broadcast/cablecast access, video headend access, and interactive video:

- **Broadcast/cablecast** access brings into the classroom educational programs and local, regional, and national information and news.
- **Video headend** access provides centralized distribution of video programs from VCR tapes and videodiscs; video bulletin boards to provide continuous up-to-date online information: live video from a production center studio or portable studio-cart: satellite broadcast reception; and remote-control-access media retrieval through telephone, dedicated control systems. or computer control systems to allow the capabilities of a video headend to be controlled from the classroom.
- **Interactive video** includes the interconnections within individual schools. within an entire school district, or nationwide. Two-way interactive video includes video conferencing, teleconferencing, distance learning, and video telephone.

The real strength of video systems is interactive video, which brings physically separated students. teachers, and classrooms together into a single teaching and learning environment. The interaction allows students to participate throughout a project and affect the outcome of an event as it happens. Consider the difference in learning between videos. films. and television broadcasts that lead us down a path chosen by a writer. director. and producer. versus live program directors and technicians who take direction from students as they progress through collaborative instruction.

Proper video display as defined by the National Television Standards Committee requires a 32 to 35-inch TV in a typical 800-square foot classroom. The standard for high-definition television (HDTV) recommends a viewing distance of three times the horizontal viewing dimension. requiring a screen width of 6 to 7 feet and a screen height of 3.5 to 4 feet. When computer graphics are introduced. the viewing size is more in line with the HDTV standard. requiring a larger screen. Whenever video will play a large part in instruction. designers should keep in mind these parameters for room design and layout.

Cabling systems and standards

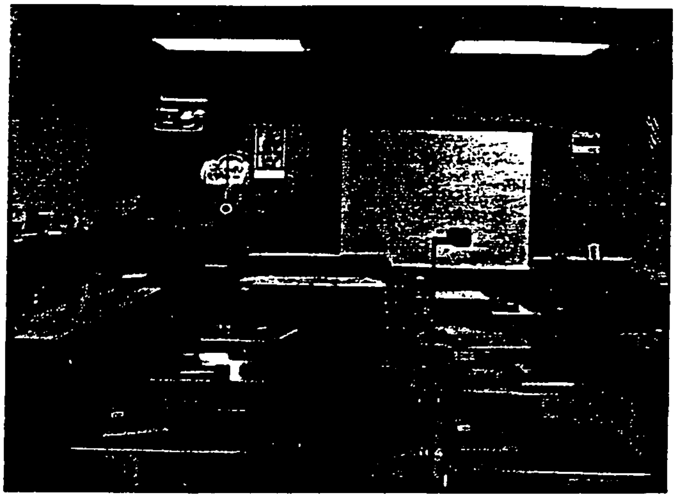
Cabling can provide connectivity for several generations of equipment and systems. By adhering to cabling standards that have been developed and supported since the early 1990s, school districts can install a "structured cabling system" that will provide a cost savings in the long run. Initial costs may be higher, but a standards-based cabling system for voice, data, and video will not need to be replaced every time a new network protocol is selected, thus reducing long-term costs. And a cabling system that is properly designed, installed, tested, documented, and maintained is more reliable. With such a system, the cable is seldom the culprit when problems arise.

Installing cable and connecting components with standards-based ratings does not necessarily constitute a standards-based installation. The standards define parameters for installation to ensure full performance potential of the cable system. The standards establish the high-performance qualities that can be expected from structured cabling systems. A Category 5 data cable system can be expected to perform at two or three orders of magnitude above the systems used in most schools today; with multimode fiber-optic cable, the order goes to four.

Many schools consider today's networks fast enough for today's needs. But advances in networking applications and faster computers will tax the capabilities of many current networks. Higher speed networks and more advanced network protocols supported by standards-based cabling systems will allow proper operation for some time to come.

Two words of advice: First, some existing systems can consolidate voice, data. and video systems—all of which require cabling—onto one cable system. But at this time and for the foreseeable future, the cost of multiplexing electronics greatly outweighs the cost of separate cable and electronics for each system.

Second, alternatives to cabling exist for each system, especially data and video. But it is important to compare the cost of the electronics that connects the systems and the true capability of each system type. Often, a performance-versus-cost comparison is not made on an apples-to-apples basis. Thus, one type of system is made to look artificially inflated, and a potentially more expensive system looks more affordable.



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Technical education classroom, Champlin Park High School. Anoka/Hennepin Public Schools. ISD No. 11, Anoka, Minn.

Infrastructure systems

In designing new schools or remodeling existing ones, it is important to provide the proper infrastructure—that is, building layout and design, communications systems, electrical power systems, mechanical systems, and pathways—to support technology needs. Those needs are changing constantly: Media centers are changing from strictly text libraries to electronic media reference, access, and distribution centers. Traditional industrial arts shops are evolving into tech-prep labs and simulation and CAD/CAM labs. Science classes are digitizing experiment results, analyzing data, and simulating physics and chemistry experiments that were impossible in the past. Classrooms and independent learning areas now incorporate technology work areas. And teachers and administrators need work areas that incorporate networked computers and telephones.

Rooms for communications systems are needed to house telephone, paging, and intercom systems, computer network hubs, servers and network control systems, and video headends. These rooms should be secure, with adequate space for operating and servicing the equipment, proper ventilation, temperature and humidity control, fire suppression, and proper lighting and electrical power. Electrical power systems should be designed to deal with the nonlinear loading that electronic equipment presents to the power system. The electrical system should also include a bonding and grounding system that meets National Electric Code and Electronic Industries Association/Telecommunication Industries Association codes and standards.

Pathway systems provide the support cables from communications rooms and closets to the multitude of outlet locations throughout a school. These systems should be designed to accommodate growth and change.

Infrastructure standards include the following:

■ EIA/TIA 569 defines standards for communications rooms, closets, entrance facilities, raceways, and conduits for the equipment and cabling systems required for communications connectivity.

■ EIA/TIA 607 defines standards for bonding and grounding of communications cabling infrastructure to ensure human and equipment safety.

Technology today and tomorrow

All schools have some form of technology already. Usually, the inventory includes computers, software, administrative and classroom telephone communications, TVs and VCRs, and data and video networking. A school district's master plan should establish minimum acceptable performance criteria for the systems, equipment, and applications. Most existing equipment will continue to be useful as the new technology plan is implemented. But don't shoehorn in existing equipment that does not fit into a comprehensive plan—it will cause continuous frustration.

A solid plan includes an implementation schedule for integrating new equipment and training staff members. The plan should be reviewed periodically as the implementation progresses to ensure consistency and accountability. Periodic updates to the plan should address any changes in technology, educational philosophy, available funding, and staffing.

The plan should also look to the future, taking into account, for example, coming changes in telecommunications. This technology took a major turn in 1996 with the passage of the Telecommunications Act. The result is competition for telephone, cable television, data networking, and new unforseen services. Telecommunications, computer communications, and video communications will arrive at our buildings in the form of copper cable, coaxial cable, fiber-optics, wireless, and satellite. Each will have benefits and detractors. Your technology designer must weigh the pros and cons of each form of communications access for your specific technology needs.

Schools that enter the networked world must also keep abreast of developments in software and in hardware security. For example, video-on-demand will replace today's media-retrieval systems with digital video jukeboxes that don't require an operator to load selected titles. And that means video will move from being a classroom strategy to a strategy used by individual students or small workgroups.

When it comes to designing for technology, no one's crystal ball is completely clear. The best strategy is, first, to stop and consider the whole picture. Then reflect on the impact a particular technology will have on student outcomes, on teaching and learning methods, and on facility operation and utilization—and reflect on its ability to adapt to constant change. ■

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Cabling Systems and Standards

- **Voice cabling:** twisted-pair copper cable. Cabling standards: EIA/TIA 568A, TSB67, TSB72.
- **Data cabling:** twisted-pair copper cable and fiber-optic cable. Cabling standards: EIA/TIA 568A, TSB67, TSB72.
- **Video cabling:** coaxial cable, twisted-pair copper cable, and fiber-optic cable. Cabling standards: broadband, FCC part 76 and SCTE; baseband, FCC and EIA.

Timesharing T1 Internet Access Through Wireless Technology

KATHLEEN SIPHER, Computer Coordinator
Potsdam Central School District
Potsdam, N.Y.

Potsdam Central School District and SUNY Potsdam entered into a unique and innovative partnership during the 1996-1997 school year. With the aid of an National Science Foundation grant entitled "Connections to the Internet," the K-12 public school and the college's residence halls were linked together via wireless technology to share the costs and the benefits of a T1 connection to the Internet. Located in Potsdam, a small rural community in northern New York state, these schools found a natural fit — to utilize the technical expertise at the college to benefit the K-12 school, and to utilize a unique funding opportunity to cut the costs for both schools.

> The K-12 public school and
> college's residence halls

SUNY Potsdam has long been recognized for their outstanding computer network. In 1993, SUNY Potsdam was recognized by CAUSE, a national organization for the advancement of information technology in higher education, as one of 25 colleges and universities around the country exhibiting the best use of their campus network. In 1997, SUNY Potsdam was selected as one of America's "Top 100 Most Wired Colleges" by Yahoo! Internet Life magazine.

Investigating Internet Access for K-12

In 1995-96, Potsdam Central was just getting started networking the school. This K-12 school district was in the middle of a $9.5 million renovation and building project. This project included wiring the entire campus to provide 10Base-T Ethernet access in every classroom, library, lab and office in the district. A fiber backbone connected the district's three buildings. With this high-performance network to be completed during the summer of 1996, the school was investigating ways of connecting this network to the Internet.

During the 1995-96 school year, in anticipation of the school's obtaining Internet access, the Potsdam Central School District undertook a comprehensive effort to provide exposure to what the Internet can provide for K-12 education. Every one of the teachers and administrators, as well as many support staff, were provided a three-hour workshop at SUNY Potsdam.

In small groups of 12, educators met at the college for a program provided by Potsdam Central's K-12 Computer Coordinator, Kathleen Sipher. This program began with a large-screen projected PowerPoint presentation that explained e-mail and the World Wide Web. After being taught how to use Netscape Navigator, the staff had around two hours to "surf the 'Net."

With the technical support from members of SUNY Potsdam's Distributed Computing/ Telemedia Department, the workshops were extremely successful in starting a drive to get Internet access to the K-12 school. Even the most reticent teachers, those who walked into the workshop convinced they couldn't and wouldn't ever use the Internet, left enthusiastic and eager to give it a try. Within weeks of the workshops, many teachers had located a local Internet Service Provider (ISP) and obtained access from home, hoping that the school would soon follow.

A Matter of Great Timing

Initial research into the costs of Internet access for the school resulted in figures ranging from $21,000 to $27,000 for just the initial year, with ongoing costs that made access almost prohibitively expensive. Throughout the network design process, SUNY Potsdam had provided technical advice to Potsdam Central, and so it seemed natural to discuss Internet access alternatives with them.

Coincidentally, during the summer of 1996, SUNY Potsdam was planning to expand their campus network to provide a new residential network with direct connections in all student rooms in the residence halls. They were concerned that the residential network would excessively increase the load on their existing network infrastructure, therefore the residential network had been designed with its own backbone infrastructure. They also were planning a separate T1 access to the Internet.

During initial conversations with Robert Jewett, Director of Distributed Computing/ Telemedia at SUNY Potsdam, the idea of sharing T1 access between the residence halls and Potsdam Central began to emerge. It would be a unique but natural partnership.

The K-12 school would use the access mostly during the mornings and early afternoons. On the other hand, residential

hall network activity would be occurring primarily during the late afternoon and evening. By sharing both the access and the costs, the two schools could maximize the potential of T1 access, with both schools realizing almost full T1 bandwidth during their most active times.

These wireless antennas are capable of a data transmission rate of 2.0 Mbps.

Since the two schools were only about a mile apart, they investigated the cost of connecting the campuses with fiber. To their surprise, the recurring cost for this connection was estimated at $75,000, plus annual costs for pole rental. Very quickly, both schools began researching alternatives.

NSF Grant Fits the Exact Need

Looking into funding opportunities, the schools were fortunate to find an NSF grant entitled "Connections to the Internet." This highly competitive grant was offered to provide for innovative ways to supply K-12 schools with Internet access. Again SUNY and Potsdam Central found themselves with a natural match and set about to apply for the grant.

Jewett and his Distributed Computing/ Telemedia staff worked to figure out the technical aspects of connecting the two schools with wireless technology. This looked like an ideal, yet cost-effective, method of obtaining T1 access for both sites. Meanwhile, Sipher set to work on writing the grant narrative. With a good deal of effort, the grant application package was completed and out the door.

Much to everyone's delight, their proposal was awarded an NSF grant! They quickly began purchasing and installing equipment. Even though the two schools are only a mile apart, there was no clear line-of-site between the two buildings. Slightly cynical as to whether or not it would work, student technicians hooked up the wireless antennas and bridges and — with a little tweaking — were able to connect the two campuses' LANs with data transmission at 100% throughput. These wireless antennas are capable of a data transmission rate of 2.0 Mbps.

Ken Smith, a student technician at SUNY Potsdam, adjusts the wireless antenna atop the SUNY administration building.

The Costs of Wireless Access

The cost of installing wireless antennas and obtaining T1 access was as follows:

Initial (One-Time) Costs:	
Persoft bridges & antennas, misc. hw	$6,600
Router/ CSU-DSU	$2,915
Total One-Time Costs	$9,515
Annual (Recurring) Costs:	
ISP Access	$18,703

The funding from the NSF grant paid for the initial hardware costs and some of the recurring costs. In the future, these recurring costs will be shared between the two schools, effectively giving each T1 access for half the cost. With the passage of the Telecommunications Act of 1996, Potsdam Central is investigating getting discounted rates for their share of the access costs.

Technical Problems

The biggest technical hurdle involved IP addressing problems. SUNY Potsdam already had Internet connection using a set of Class B addresses. With the additional T1 connection for the residence halls, their Internet Service Provider was unable to split the Class B addresses across both connections. Furthermore, because of InterNIC policy, SUNY Potsdam was not able to get additional address space. Thus they found themselves unable to use their present address space and were unable to obtain other addresses.

Ken Smith and Justin Sipher check out the wireless antenna.

As a temporary solution, the ISP set them up with a firewall that does "IP Masquerading." This allowed SUNY Potsdam's residence halls to go online despite the contradictory addresses. SUNY Potsdam is still working with their ISP to change its backbone routing strategy to accommodate for this addressing issue.

Potsdam Central, meanwhile, obtained a Class C license and was brought online in January of 1997. With only 4 1/2 months of the school year left, Potsdam Central began hooking up local desktop Macs and PCs to the Internet. And their teachers and staff set about using the Internet within the classroom.

How the K-12 School Benefits

One of the biggest advantages of the shared Internet access is that technical experts at SUNY Potsdam can easily and quickly provide technical assistance to the K-12 school. For instance, as the school began setting up an Internet server for the first time, Justin Sipher, a senior systems analyst for SUNY Potsdam (and coincidentally Ms. Sipher's son) worked remotely on the Internet server, assisting Ms. Sipher in setting up DNS, e-mail and Web services. Using Timbuktu Pro software, Mr. Sipher was able to remotely take control of the Internet server at Potsdam Central, changing settings and configuring it as if he were sitting right in front of the server.

SUNY Potsdam hopes to use the connectivity to provide for preservice education and student teacher programs.

An additional exciting advantage of Internet access was found in another partnership that Potsdam Central arranged with a different local college. With the aid of Twin States Voice.Data.Video, a telecommunications firm in N.Y., Potsdam Central and Clarkson College, also Potsdam, began offering a joint class in Information Technology for students at Potsdam Central. Along with a graduate student assistant, Ms. Sipher taught the class during the second semester of the 1996-97 school year. Student schedules were already pretty full, so the class was offered after school for two hours on Mondays and Wednesdays. Despite the fact that it meant giving up other after-school activities, the class was quickly filled up with students from grades 9 to 12.

The Information Technology class took several field trips to SUNY Potsdam and Clarkson University to listen to experts in the field. Several other local experts met with the class at the high school. The Internet Consulting Group at Clarkson College worked closely with the class to teach them how to create Web sites and Web pages. This resulted in the development of a Web site for Potsdam Central School at http://www.potsdam.k12.ny.us.

How SUNY Potsdam Benefits

While not yet in progress, Potsdam Central School and SUNY Potsdam hope to use the connectivity of their two separate LANs to provide for preservice education and student teacher programs. SUNY Potsdam has one of the largest teacher education programs in the State University of New York system. Imagine being able to access student projects on Potsdam Central School's LAN from the college classroom as student teachers and their professors discuss the benefits and problems involved in using technology in education. Preservice education majors and student teachers can create and save presentation material while on campus and then access this information when they are in the K-12 classroom. Myriad potential uses of the connected LANs can easily develop into exciting new avenues to prepare new teachers to teach.

The opportunities that these connected LANs provide will only be limited by the imagination and energy of the teachers and students at both SUNY Potsdam and Potsdam Central. While these schools are located in a rural region of northern New York state, they are no longer as isolated as before. As the new school year gets under way, teachers and students at Potsdam Central are beginning to utilize the access to obtain information, while SUNY Potsdam begins to use its shared access as it trains new teachers for the Information Age.

Potsdam Central School's Web site: www.potsdam.k12.ny.us

Kathleen Sipher *is the K-12 Computer Coordinator for Potsdam Central School District in Potsdam, New York. She helped plan for and install the wireless connection between Potsdam Central and SUNY Potsdam. Sipher was also instrumental in writing the NSF grant that was used to purchase the wireless bridges and antennas.* E-mail: sipher73@slic.com

Companies, products & groups mentioned:

Timbuktu Pro; Farallon Communications, Inc., 2470 Mariner Square Loop, Alameda, CA 94501, (510) 814-5100, www.farallon.com

Netscape Navigator; Netscape Communications, Mountain View, CA, home.netscape.com/

Twin States Voice.Data.Video, Morrisonville, NY, (518) 563-7100, www.twinstates.com

Persoft Intersect Wireless, Persoft, Inc., 465 Science Drive, Madison, WI 53744, (800) 368-5283, www.persoft.com

CAUSE; 4840 Pearl E. Circle, #302E, Boulder, CO, 80301, (303) 449-4430, www.cause.org/

(Left to Right) Robert Jewett, Justin Sipher and Kathleen Sipher access the Web with their new T1 access.

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Feature Forum: Log onto T.H.E. Online and join your colleagues' discussion of articles in our new Forum areas. Authors have provided "seed questions," or leave a comment or query of your own.

Am I on the Mark?

Technology Planning for the E-Rate

Strategic technology planning requires considerable time and effort, but most experts agree that it's worth it. And technology planning is under scrutiny in the United States while schools and libraries are preparing to apply for government-funded discounts on telecommunications access and equipment. But how do you know whether you are planning wisely? This article describes the required components of a sound technology plan and their functions.

By Dr. Chip Kimball and Peter H. R. Sibley

During its 1996 session, the U.S. Congress passed the Federal Telecommunications Act by a wide margin. This legislation provides the most aggressive funding formula ever to integrate telecommunications technologies into public schools and libraries: More than $2.2 billion per year will be provided to schools to "break down the informational barriers created by geographical boundaries." Funding covers access charges and some equipment and services needed to set up a network. School advocates across the country are applauding the legislation and its expected consequences.

Schools and districts are anxious to apply for the "E-rate" discounts that become available with the act's funding in January 1998. (Access some of the Web sites listed in the sidebar on the opposite page for more information about the E-rate.) As described in the details of the E-rate implementation plan, a technology use plan (TUP) must be submitted as part of an application; it will be reviewed by the authorizing agency established by the Federal Communications Commission (FCC). Although most educators would agree that effective planning is critical for successful implementation of technology, the E-rate requirement has raised the stakes for school planning. The TUP requirement forces educators to ask a compelling question: "How do I know if my TUP will meet the E-rate requirements?" But an even more important question is, "What are the components of a strong TUP?"

As a process, technology planning requires substantial time, energy, and resources. Most experts agree that the process of planning—especially engaging colleagues and stakeholders in meaningful dialogue and decision-making process—is as important as the production of the document itself. To capture effective planning practices and add powerful planning tools, Kimball and Sibley (1997) developed their Technology Maturity Model (TMM) for educators. This comprehensive model builds a framework for organization change and increased student achievement through the use of technology and should help educators in their planning.

One of TMM's most compelling tools is the Technology Plan Analysis Rubric (see the rubric charts on pages 56–57). This tool is used to evaluate whether a TUP has the elements considered "essential" as described in educational research and confirmed by practicing technology coordinators (Kimball, 1996). Although E-rate criteria for plan evaluation will most likely vary by state, if your TUP meets the criteria outlined in level 3 or 4 of the rubric, then you are on the right track.

Technology-planning materials consistently include certain components. Here the plan analysis rubric can be used before the planning process as a guide or as an evaluative tool afterward. The rubric has been used to evaluate more than 200 plans in California (Kimball, 1996) and is currently being used by several Midwestern states as their statewide tool. The plan analysis rubric is thus designed to guide a school while it works through the technology-planning process. It is best used in conjunction with the other components of the TMM.

Essential Components of a Strong Technology Use Plan

Broad-Based Support. The TUP's committee membership section identifies both contributors to the plan and the process used to select members. All constituencies should be represented: students, teachers, administrators, parents, educational institutions, and community members. Key players in decision making should also be identified, especially those who contribute to the culture of the organization but who may not have official

decision-making positions. People who are highly respected by their professional peers and who are consistent voices for rational change should also be included. Researchers have also found that technology use is sporadic and slow when most staff members have not been included in planning—that is, when staff members are asked to apply technology to problems that they have not been asked to help define (Sydow & Kirkpatrick, 1992).

Needs Assessment. This assessment is used to determine what needs to be done; it provides information and baseline data to establish progress on objectives. Information from students, teachers, administrators, and parents should be included as data is collected. Information is also needed about equipment, software, and facilities in addition to the assessment of behaviors, policies, and organizational structures.

The initial needs assessment for a strategic technology plan should, in most cases, cover more than a school's technological condition. It should include an analysis of the community, educational values, enrollment data with demographics, and facility information. As assessment data is analyzed, aggregates are established and benchmarks are used for comparison. Trends and generalizations are built from needs assessments to help build a rationale and direction for the plan. Data should be collected and compared on a regular basis to monitor progress. Several needs assessment instruments are included in the TMM, including the maturity model benchmarks and a hardware inventory.

Using an Organization's Vision and Mission. An organization's mission and vision should be central to the strategic-planning process. Without this connection, a technology plan is doomed to failure. Almost by definition, strategic planning is long-range planning with a vision. When an organization's members select a mission, everything that follows should be based on it. A technology-planning document is part of that process. It should focus on a district's or school's educational philosophy and priorities and how these philosophies and priorities relate to teaching and learning, not just how they relate to technology.

A strategic-planning document should distinguish between an organization's mission and its vision. A *vision statement*—which is collaboratively built through discussions, data collection, and self-analysis—reflects a teaching and learning environment under ideal circumstances. This vision is holistic and may be unattainable, but it does provide a clear direction for the school's or district's work. The mission, on the other hand, is a holistic goal based on the vision. In the technology plan, the mission specifically addresses the issue of technology and what will be done to implement it while working toward the vision. It is from this mission (and vision) that specific goals will be built and action plans put into place.

Goals and Objectives. After a technology mission statement has been tied to the organization's vision, specific goals and objectives are developed to move the organization toward its vision.

Web Sites for E-Rate Information

EdLinc
http://www.itc.org/edlinc/discounts

Federal Communications Commission
http://www.fcc.gov.learnnet

ISTE
http://www.iste.org

National Exchange Carrier Association
http://www.neca.org

Merit
http://www.merit.edu/k12.michigan/usf

Planning with the Technology Maturity Model
http://www.edmin.com/techplanning

U.S. Department of Education
http://www.ed.gov/Technology

Goals are more specific in nature and will typically address specific areas based on the information gathered in the needs assessment. Goals should also reflect a general direction or performance for the school or district over some set period of time. Each goal should have a clear purpose and be attainable, measurable, and appropriate. Well-written goals should be broad based and address specific teaching and learning issues.

Objectives are derived from each goal. They are more detailed and define how the goals will be met with specific task and time targets. Objectives also serve as milestones of goal-supporting accomplishments.

Action Plans with Timelines. An action plan in a strategic-planning document delineates the specific steps required to bring desired changes as articulated by prioritized goal statements and objectives. The action plan should further define each goal or objectives by specifying timelines, assigning responsibilities, and clarifying budgets. Staff development is especially important when technology is introduced and action plans are formulated. Most researchers agree that even extremely valuable educational innovations will not be implemented without strong staff development.

For many schools, however, action plans are carried out as little more than sophisticated shopping lists. An effective action plan should contain a specific, understandable, and quantifiable series of steps that a school will follow through the course of planning and implementation. Without these specific components of the action plan, the implementation process loses much of its potential impact because there is no accountability.

Program Integration and Curriculum Integration. Most educators agree that technology use should ultimately be treated a tool to improve student achievement. We find, however, that because of its complexities and introduction, technology is often treated separately in the curriculum and in how relates to other school and district programs. Effective technology planning considers and highlights its connections with other planning efforts. How comprehensively that is done depends on other planning in the school. A strong technology plan not only describes the technology skills associated with its implementation, but also how technology will affect student achievement in a comprehensive and measurable fashion.

Evaluation. The evaluation of educational programs, including technology use as it is integrated into the teaching and learning process, is one of our greatest educational challenges. Without strong, rational evaluation, educators will neither be able to make corrections during the implementation process nor be able to determine if they are heading in the wrong direction. Thus evaluation should become a component of the technology-planning process as well as plan implementation and outcome.

Evaluation should take place at two levels. First, it should annually measure a plan's overall scope and how it complements the school's or district's overall vision and mission. Second, each outcome in the plan should be measured. Most experts agree that such assessments should be specific to a tangible and measurable outcome—that is, one that is time-based and has artifacts of completion. It is important to assess not only how technology equipment is implemented and used, but also how it affects specific learning outcomes as outlined in the technology plan's broader discussions. Although more complex, this kind of measurement adds a new level of accountability to the technology planning and implementation process.

Multiyear Planning. The unwillingness or inability of public schools to provide multiyear funding—and thus multiyear planning—is one significant problem that strategic planning faces. One-shot planning and funding does not facilitate successful technology implementation. Too often, a one-shot process carried out under time and budget pressures must focus on what is already known. When a strategic technology plan is put into place, however, funding for several years must be considered and addressed; therefore, the ongoing planning process is essential.

Standards. Local decision making is common across the country now. With the trend, however, has come a tendency to implement technology solutions to address local problems without recognizing larger and longer-lasting connectivity and support issues that will plague a school after implementation has started. Standards are crucial to long-term success, and setting standards is critical in addressing issues of compatibility, flexibility, and resource management.

In most cases, standards should be set at the district or regional level because most support requirements are addressed at this level. This provides an interesting challenge for technology planners. The standards found in a strong technology plan should be flexible enough to allow schools to design locally appropriate solutions while also providing adequate and cost-effective support at the district or regional level. Areas that should receive special attention in a technology plan include model classroom configurations, facilities, software, copyright, and donations.

Standards are diverse and change constantly. They may be volatile, such as the type and speed of microcomputer to be used, or relatively stable, such as electrical-wiring requirements for computer labs. In either case, resources are far too scarce to waste because of a lack of standards and poor purchasing decisions.

Funding and Alternatives. Although often staggering in scale, technology-funding projections are essential to a strong technology plan. As a plan develops, both projected expenses and possible funding sources are needed. As schools and districts are faced with funding challenges, innovative funding scenarios will be required that challenge the conventional thinking. The TUP should outline these innovations.

Research and Development: Pilot Projects. Most experts suggest that, before any innovation or solution is adopted, a pilot project should be used to identify issues, build support structures, and study scalability. Such research and development (R&D) can contribute significantly to solving extremely complex problems. A strong technology plan allows for R&D efforts so that those implementing the plan can continue moving forward with technological innovation. Note, however, that any such R&D process should be closely linked to the TUP's overall objectives and considered within the context of scalability. The purpose of R&D is not to acquire the latest and "coolest" stuff, but to study possible systemwide solutions.

Educational Research. Most educational programs require the support of the growing educational research base. This principle also applies to educational technology. In a strong technology plan, research is not only referenced as it applies to technology, it also addresses the larger learning issues associated with how the technology will be used in the curriculum. Educational research references should be directly correlated to the technology efforts, building a foundation for the plan.

Staff Development. Adequate staff development is probably the most significant obstacle to effective technology implementation. Effective staff development is complex, diverse, and resource intensive. A strong TUP should address staff development comprehensively and using a variety of approaches. The resources committed to staff development will probably be linked directly to the success of technology implementation.

Summary

Although strong technology-planning components are fairly obvious, the effectiveness of any strategic-planning document depends equally on the processes for planning, communicating, implementing, and evaluating technology. Also important to such a document are the processes used to create it, the purposes it should serve, and the environment in which the implementation is to take place. The components outlined here (and found in the plan analysis rubric on the following pages) are only as powerful as the processes used to create them. ■

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References

Kimball, C. (1996). *Technology planning in California schools: Planning for success or doomed for failure?* Unpublished doctoral dissertation. Los Angeles: University of Southern California.

Kimball, C., & Sibley, P. (1997). *The technology maturity model primer* (rev. ed.). San Diego, CA: Edmin Open Systems.

Sydow, J. A., & Kirkpatrick, C. M. (1992). Inject reality into your technology planning. *School Administrator, 49*(4), 31–33.

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Rubric for Technology Plan Analysis

Criteria	1	2	3	4
Broad-Based Support Contributions (Administration, Teachers, Students, Community, Staff)	A list of contributors is not provided.	A list of contributors is provided but does not describe their constituencies. Equitable representation is not apparent because of a lack of detail.	A comprehensive list of contributors describes their constituencies. Representation is provided by at least three of the objectives five areas. The principal is included.	A comprehensive list of contributors describes their constituencies. Representation is across all five areas of the objective. The principal is included.
Broad-Based Support Process	No process for equitable representation is described.	The process to ensure equitable representation is briefly mentioned, not emphasized.		The process to ensure equitable representation is emphasized and mentioned in detail.
Breadth of Needs Assessment	A needs assessment is not provided.	A needs assessment is referenced but covers only one element of the school environment (equipment or staff development, but not both).	A needs assessment is referenced and more than one element is analyzed, but it does not completely assess staff, student, and community needs.	The needs assessment is comprehensive and consists of detailed information about staff-development needs and competencies, attitudinal surveys, equipment inventories, and school and district context.
Depth of Needs Assessment	Broad generalizations are made about what the school needs but without reference to an assessment.	A needs assessment is referenced, but the instrument is informal, brief and not specific. For example, a computer count is provided without details on where or how they are used.	A needs assessment is referenced with some level of detail, although the instrument and data are not provided and additional detail may be needed on collection and analysis.	The assessment in any given area is detailed and thorough. The instrument and generalizations about the data are provided. Raw data may be included in an appendix.
Needs Assessment of Equipment	No equipment inventory is provided.	An inventory exists only for computers and without indicating vintage.	The inventory moves beyond computers to include phones and television, but it does not address infrastructure or equipment vintage.	A comprehensive equipment inventory includes computers, infrastructure, access, interactive television, telephones, and other equipment.
Mission and Vision	No clear mission or vision is articulated.	Vision is skill-based only and does not address larger school or district outcomes.	Vision focuses on technology outcomes and avoids presenting a learning outcome.	Vision is comprehensive and deals with large learning outcomes of students, not just technology outcomes. The statement identifies the learning process skills and values.
Goals and Objectives	General learning goals are unclear or absent.	Goals are equipment-based instead of based on learning outcomes. Objectives are unlinked to goals or absent. Objectives or goals are neither measurable nor obtainable.	Goals are broad and comprehensive but not completely clear. They are linked to objectives but are not readily obtainable or measurable. Goals are loosely tied to state or district documents.	Goals are broad and comprehensive, addressing teaching and learning needs, as well as being clear, attainable, and measurable. Objectives are delineated from goals and further define how they will be met.
Action Plans with Timelines, Responsibilities, and Budgets	An action plan exists, but timelines and responsibilities are nonexistent or limited. Assessment is not mentioned. The plan is not curriculum-based.	The action plan is tied specifically to the goals and objectives, although identified task, timeline, responsibility, funding, and assessment are incomplete and several elements are missing.	The action plan is tied specifically to the goals and objectives. Identified task, timeline, responsibility, funding, and assessment components are thorough, although one or more elements are missing.	The action plan is tied specifically to goals and objectives. Each task identifies a task, timeline, responsibility, funding, and assessment.
Program Integration	The document never mentions connections with other efforts.	The TUP mentions other efforts but is not explicit in connecting with them.	The TUP is loosely coupled to other documents and needs, and program changes are integrated much of the time.	The TUP is tightly coupled to the other reform, curriculum, or accountability documents, with the approach fully integrated.
Curriculum Integration	The plan focuses on technology outcomes and skill-based goals, and does not address how it can enhance curriculum.	The plan mentions curriculum integration and enhancement but lacks detail.	The plan specifically identifies how the curriculum can be enhanced by the use of technology with detail. A technology-rich environment is described, but strategies for enhanced teaching are not explored thoroughly.	The plan specifically identifies not only how technology enhances the curriculum, but also what a student using the technology may do in such an environment. The plan addresses strategies of teaching and learning that can be enhanced as a result of technology integration.
Evaluation	No formal evaluation is described.	An evaluation process is described but without detail, comprehensiveness, or reference to learning outcomes.	An evaluation process and instrument is described in detail, but without comprehensiveness. Links to goals and objectives are not apparent.	An evaluation process and instrument are described in detail and are comprehensive in nature. Evaluation is timely and tied to objectives.

Criteria	1	2	3	4
Multiyear Planning	A timeline is not mentioned.	The plan covers only one academic year or project.	The plan covers more than one year but is short-term in nature and does not refer to ongoing planning and support	The plan is multiyear and shows its links to multiyear funding, support, and planning activities.
Standards	The document does not mention equipment or software standards beyond brand names.	Equipment standards are mentioned but not well specified.	Equipment standards are specific but narrow in scope	Equipment standards are specific and comprehensive, and a process describes how they will be used.
Funding Alternatives	Funding resources are not mentioned.	Funding is mentioned, but it primarily focuses on budgeting or specific site funding without addressing other income needed to implement the plan.	Specific funding sources are described but limited to traditional sources and without specific budget figures.	Specific funding sources are described, including current and future funding sources; it also includes information on reallocation and use of resources and budget figures.
School Pilot Projects (Research and Development)	No R&D projects are mentioned or planned as part of the project.	R&D efforts are mentioned but lack detail. No timelines, assessments, or scalabilities are mentioned.	Specific R&D efforts are described, but scalability is not articulated. Timelines and measurements are mentioned but are not specific.	Specific R&D efforts are described, with implications for future work (scalability) articulated. The R&D efforts have a timeline and measurable instruments in place.
Educational Research	No educational research is mentioned as part of the project.	Educational research is only broadly mentioned.	Specific educational research is mentioned but without connections to school efforts.	Specific educational research is mentioned and connections are made to school efforts.
Model Classroom Configurations	No classroom or school configurations are described.	Classroom configurations are mentioned but lack detail. (e.g., "there will be three computers and a printer in each room").	Classroom configurations are described in detail but may be restrictive as the "only" right way; typically, only one type of configuration is described.	Classroom and school configurations are specifically described with links to teaching and learning outcomes. They are provided as possible solutions to particular problems but are not prescriptive in nature.
Facilities (Electricity, Security, Etc.)	Facilities issues are not mentioned.	Facilities issues are mentioned but lack enough detail to build into an action plan.	Facilities issues are identified and articulated, but solutions and suggestions lack detail or clarity.	Specific facility issues are identified, addressed, and include recommended solutions, budgets, and responsibilities.
Maintenance and Support	No maintenance and support are provided.	Support plans are mentioned but without enough detail or clarity to implement.	Support plans are mentioned with clarity and detail but do not consider long-term issues.	Specific support plans are articulated. This included the process for specific support issues and ongoing equipment replacement, staff development, and repair.
Software Agreements (Site Licensing and Policies)	No software agreements or policies are mentioned.	Software agreements and policies are mentioned, but specifics are not articulated in the plan.	Specific software policy is articulated but not tied to site needs.	Specific software policy is articulated and plans are given for accommodating software needs at the site.
Copyright and Acceptable-Use Policy	No copyright or acceptable-use policy is described.	Copyright and acceptable use are mentioned, but the plan does not articulate specific policies.		Copyright and acceptable use policies are articulated in the document, and samples are available.
Gifts and Disposal	No policy is provided for disposing of and receiving gifts of equipment and services.	Policy is provided but is not clear or articulated.	Specific policy is articulated about disposal and gifts, but it is not tied to the standards.	Specific policy is articulated about moving and disposing of equipment. Gift acceptance is tied directly to standards.
Staff Development	The document does not mention staff development.	Staff development is mentioned but not clearly articulated as to its accomplishment or evaluation.	Staff development is articulated but limited to single modalities and is not clearly supported by resources.	Staff development is addressed either in the action plan or in a separate section. It includes multiple strategies, incentives, and resources.

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Telecommunications Infrastructure In New School Buildings: The Basics of Cabling and Connecting

Caveat: Include Telecommunications in Your Plans and Budget From The Start!

------10 Most Frequently Asked Questions-----

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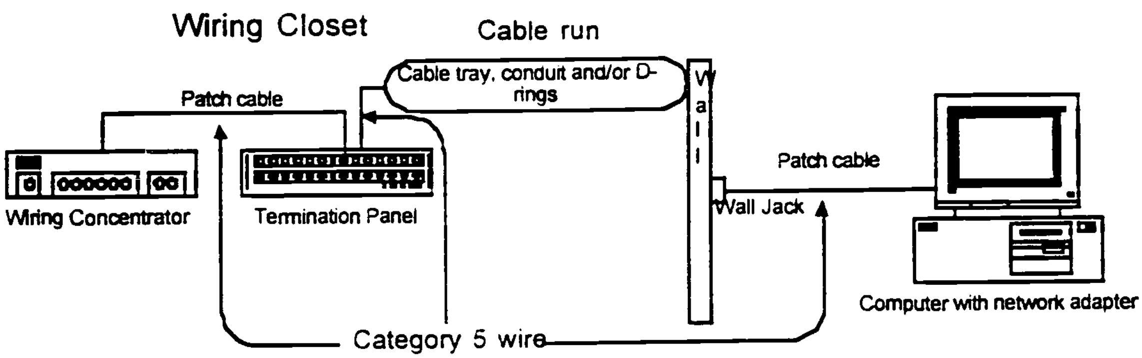
compiled and distributed by
SD Department of Education & Cultural Affairs
Karon L. Schaack, Secretary

1. If we want to network the classrooms together in our new school building (i.e., a local area network or LAN), what infrastructure should we plan to install?

Local Area Network Infrastructure



A local area network is defined as a link between two or more computers that lets the computers exchange information. The following list discusses the components of networks, and some of the items necessary for network planning purposes.

Two items that facilitate network planning are:

Building blueprints: These are important in determining an appropriate location for the wiring closet along with defining the paths where cable can be pulled. If the blueprints are current, they can help identify the easiest, safest and most efficient path for pulling the cable.

Local codes: Be knowledgeable of the building codes of your particular town. Building codes may prohibit drilling or cutting holes in fire walls or ceilings. Also, some parts of a building may contain materials like asbestos or PCBs that must be handled only by trained technicians. Check with your site administrator to be sure you don't compromise safety in the building.

Infrastructure components:

Wiring closet: A designated location that is to serve as the "wiring closet". This room may also be the telecommunications or "phone" room where all of the telephone lines come into the building. The wiring closet is where the local area network termination equipment will be located.

Cable runs: A defined path for the cabling to be pulled from the classrooms to the wiring closet. Similar to surveyors planning where a street or highway will run.

Cable trays or conduit: located in the ceiling fulfill the defined path from above. This serves as the method of transporting the cable from the classroom to the closet. "surface located" mountings are also a transportation alternative. This involves running the cable on the outside of the walls or ceiling and then covering the cable with a protective plastic or metal molding. A popular method for existing buildings is to use "distribution rings" (d-rings). D-rings are attached to the building wall or ceiling. The cable trays, conduit or d-rings serve as the streets or highways to deliver the wiring. Analogous to how roads deliver vehicles to their destinations.

Cable: This is the physical wire that will connect the computers. The most popular types are Category 5 unshielded twisted pair and multi-mode fiber optics. Category 5 is a copper wire (made up of 8 individual wires or 4 pair of wires) that is used to connect the computers to the wiring concentrators in the wiring closet. (As a point of reference, typical household installations use Category 3 telephone cable which is made up of 4 wires or 2 pair of wires.) Fiber optics are used to connect computers or networks that are geographically separated by a large distance (over 300 feet).

Patch panel: The patch panel acts like a "switchboard" where all of the cables from the classrooms connect to. The patch panel is mounted in the wiring closet on a wall or free-standing unit. A typical patch panel can have 24 individual cables connected to it.

Wall jacks: The wall jacks are installed in the classroom on a wall near where the computers are going to be located. The Category 5 cable is plugged ("terminated") into the wall jack. The wall jacks are called "RJ-45" jacks. For comparison sakes, a regular telephone has a RJ-11 jack that connects a telephone to the telecommunications network.

Patch cord: A short piece of Category 5 cabling that has a RJ-45 jack on each end. A patch cord is used in two (2) situations. The first is to connect the computer to the wall jack. The second is to connect the other end of the cable that is terminated in the wiring closet patch panel to the local area network concentrator.

Wiring concentrator: A piece of electronics equipment that forms the "network." Each individual cable run plugs into the computer at the classroom end of the termination and plugs into the wiring concentrator in the wiring closet. The "network" is formed by each of the individual cable runs plugging into the concentrator. Concentrators typically come in multiples of 12 and 24.

Topology: The topology is the type of network that is installed. The most common topologies are ethernet and token ring. Ethernet operates at speeds of 10 and 100 millions (m) of bits per second (bps). Token Ring at 4 Mbps and 16 Mbps. Ethernet is the recommended topology.

Network interface card (nic): each computer you want to connect to the network requires a network interface card. Also called a network adapter.

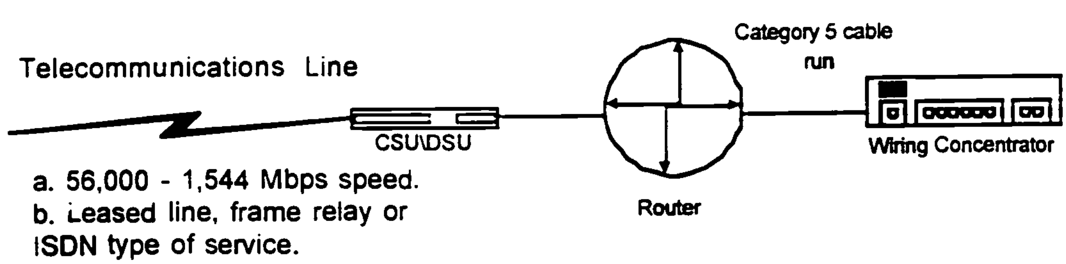
File server: an additional computer with nic is required as a "hub" to share information and data among computers. The file server is normally the computer which is the fastest one in your network.

Network operating system (nos): The NOS is the software which allows the computers on the network to talk to each other. The most popular network operating systems are Windows NT, Novell Netware and Appletalk.

Printers and other peripherals: A wide variety of peripheral devices can be connected to a network. These include such things as printers, CD-ROM towers, additional hard drives, etc.

2. And if we want to take the next step and network all the buildings in our district together (i.e., a wide-area network or WAN), what infrastructure is required?

Wide Area Network Infrastructure



A wide area network is a collection of local area networks connected together.

The following example assumes the buildings are geographically dispersed enough that physically connecting them by fiber optics is not feasible. For creating a wide area network, the pieces required are:

Router: A computer that connects two (2) networks. It is a device that routes packets of information between networks. Similar to how traffic cops route vehicles between streets. The router is connected to your local area network and to the CSU\DSU.

CSU/DSU (Channel Service Unit / Data Service Unit): One device that performs two functions - like a regular modem that connects a phone line to a computer but it works at higher speeds and in a digital environment.

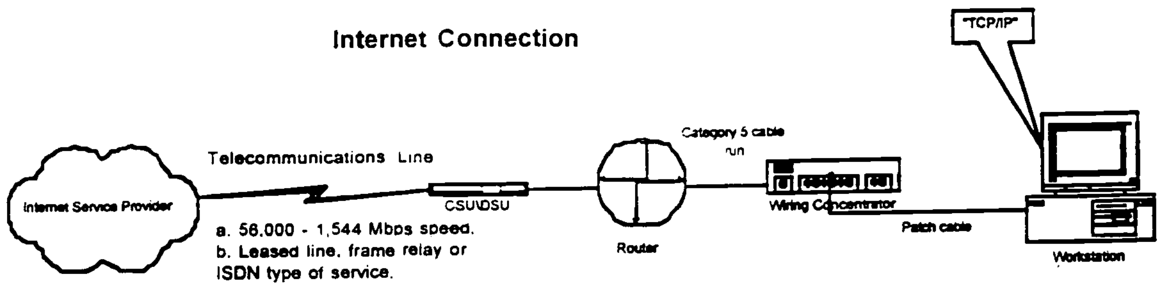
High speed phone line: A digital phone connection from a telecommunications provider. The most common speeds available are 56K and T1. Some technologies allow speeds in between. These are sometimes called "fractional T-1" lines. While local area networks operate at speeds of 4, 10, 16 millions of bits per second (bps) and higher, in comparison these connections are significantly slower at 56,000 and 1.54M bits per second. On the other hand,

typical modem connections from a computer vary from 2,400 bps to 28,800 bps.

Type of service: The high speed digital telephone lines come in different flavors. Leased line, frame relay and Integrated Services Digital System (ISDN) are the most popular. The exact type to use depends on availability, costs and requirements.

WAN connection: Needed for each local area network which wishes to share information with other local area networks.

3. What do we need to add to link our network with the rest of the world (global networking)?



You will need a wide area network connection, as mentioned above, from an Internet Service Provider (ISP) (i.e. the state, a private company, a university, etc.) to your location. The ISP has a multi-port Internet connection; by connecting your network into one of its ports. the ISP will provide you access to the world wide Internet.

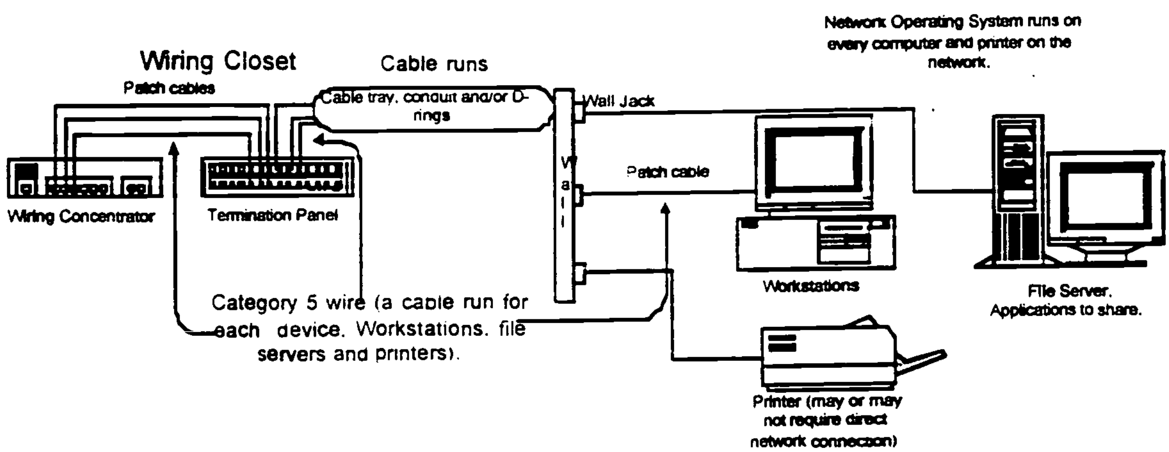
Internet addresses: Each computer which will talk to the Internet needs a unique address. This address is similar to the name, street, city and state combinations that makes up our home address. The address may be made available to you from your ISP. Addresses can be shared among multiple computers with the right type of software.

Software on each computer: The most popular type of Internet service is called world wide web (WWW). To access the WWW, a piece of software called a browser is necessary. Other popular services are electronic mail, telnet and file transfers (ftp). Each of these services requires a piece of software. The software may be integrated into a single product, such as a WWW browser, or it can be packaged separately.

Internet Protocol: The Internet speaks a language called "TCP/IP" (Transmission Control Protocol/Internet Protocol). The computers on the local area network must speak this language.

4. We have both Macintosh and IBM Compatible (Wintel) computers. Can these be networked together, and can they all be connected to Internet?

Local Area Network Components



Yes, it is possible to network a mix of computer types together. As a matter of fact, within the last couple of years, "mixed platform" networks have become increasingly common. For schools who already have a variety of computer types, this is particularly important in order to protect and maximize their technology investment and, more importantly, to meet established educational goals and objectives with a wide variety of educational software.

There are numerous sources of information about how mixed platform networking can be accomplished. One such source is entitled *Computer Networking for Educators*, 2nd edition by Ted D.E. McCain & Mark Ekelund (Available from the International Society for Technology in Education [ISTE]). This publication includes chapters explaining IBM compatible (Wintel) networks, Macintosh networks and mixed IBM compatible and Macintosh networks. In addition to such sources of information, it is wise to seek assistance for a competent network specialist who is familiar with mixed or cross-platform networking

One thing to remember about creating networks, especially mixed platform networks, is to be sure that all computers being connected to the network adhere to certain standards. For instance if you will be using the recommended ethernet networking, it will be necessary for each computer to be outfitted with an ethernet network interface card (nic) which matches the speed of the ethernet being installed (10 Mbps or 100 Mbps). In addition, each printer or other peripheral will require ethernet capabilities as well.

In addition, all computers that are to be connected to Internet must be able to "speak" the common language of the Internet. This language is called Transmission Control Protocol/Internet Protocol (TCP/IP - often also referred to as simply "IP"). TCP/IP programs are readily available as shareware or freeware for computers using older versions of most computer operating systems (OS). In addition, TCP/IP is generally included as an integral part the most recently released versions of many computer operating systems. For instance, TCP/IP is included with all Macintosh OS versions later than System 7.5.3. It is also included in Windows 95.

When selecting a network operating system (NOS) and server, be sure they support a cross platform environment. Novell Netware and Microsoft's NT Server are both very capable of supporting cross platform situations.

While a mixed platform network adds a layer of complexity to your network, it will be worth a little extra attention to details if you are better able to accomplish your educational goals in this environment.

5. What electrical system is needed to support LANs and WANs?

The "Wiring the Schools" project has confirmed previous suspicions that few schools are adequately wired to support the electrical needs dictated by current educational technology. Often, electrical outlets are limited to one in the front of the classroom and one in the back of the room. The exception may be in classrooms which have been rewired in recent years for use as computer labs.

To properly upgrade schools, it is often necessary to not only increase the number of outlets but also to add new circuits to support these increased outlet numbers. At times it is even necessary to increase the amount of electrical service to the building. Care should be taken to insure that upgrades adequately meet current and projected future needs and meet all safety standards.

Consultation with a professional electrician is a must before beginning this process. The electrician is not only knowledgeable about the multitude of safety and other standard that must be met but is also experienced with ascertaining and planning for meeting all of the electrical needs of the computers, peripheral devices, and other network components that you plan to use throughout the school. Planners can assist the electrician and avoid costly future upgrades by presenting the electrician with a clear picture of the quantity and type of equipment that will be needed in each location throughout the school.

It may be helpful to know that the "Wiring the Schools" project currently uses the basic standard of <u>one 20 amp circuit for each six computers with monitors.</u>

In addition to instructional and administrative areas, planners should allow for realistic future expansion and consider needs in service areas such as the wiring closets. Service areas are often located in parts of the school (closets, utility rooms, etc.) that were not originally designed for this new purpose and therefore lack adequate electrical service. It is essential that they be upgraded in order for the network to function.

6. What applications can be efficiently used with a LAN? a WAN? a global link?

Schools quickly find a whole new world of challenges and opportunities when moving from using only "stand-alone" computers into a networked environment. The challenges center primarily around learning how to use networks and what to use them for.

Network applications generally fall into one of two categories. While the distinction between these two are not always perfectly clear (they are often seen as "two sides of the same coin"), the shades of differences are fairly significant. The two areas are: Those which increase "communications options" and those which increase "access to information."

E-mail is perhaps the most used network application. E-mail allows teachers to communicate more conveniently and efficiently with their colleagues throughout the school building and beyond. Indeed, when a local area network is connected to the Internet, it is possible to communicate with colleagues around the world. In a matter of mere seconds, ideas and information can be shared with other networked individuals and groups no matter where they may be located.

Newsgroups and Mailing Lists (Listservs) are e-mail based or e-mail "like" applications which add another layer of utility by allowing one person to communicate with may others. These two applications are Internet based applications which are usually created to deal with specific subjects or areas of interest. Listservs are handled primarily through e-mail. You can "subscribe" and "unsubscribe" to one as often as you wish (no charges are involved). Once you are subscribed you will receive all messages sent to the list by other subscribed individuals.

While listservs are handled strictly through your e-mail program, Newsgroups are similar to e-mail only in the way that messages are sent. However, you do not automatically receive all messages. Instead, you must "enter" the newsgroup each time you wish to read or send messages. To do so, you will need two things. First, you will need to have access to a server that carries the newsgroup in which you are interested. Secondly, you will need "newsreader" software. As with many

Internet applications. Both listservs and newsgroups are increasingly found on and can be participated in through WWW pages.

It should be noted that caution is advised with allowing student access to newsgroups. Because newsgroups can be found that deal with practically every subject under the sun, and because they are not always well moderated or controlled, they often contain very frank, sometimes obscene language and may even contain pornography of all types.

E-mail also allows students to similarly communicate with peers, subject matter experts, mentors and others on a global basis. In addition, teachers and students can more quickly and easily communicate with each other. This may consist of electronically transmitted assignments and course related materials to students, student transmission of completed homework to teachers, e-mail based question and answer sessions, teacher feedback to students, and more. In many cases, e-mail communications have proven more effective than usual forms of communication primarily because barriers of sex, age, race, social class, etc. have less meaning without face-to-face contact. It has been said that the Internet promotes the exchange of ideas without the taint of unrelated information.

In addition to e-mail, networks enable users to easily exchange and/or use shared documents, graphics, etc. These may be homework assignments, presentations by teachers or students, announcements, demonstrations, etc. that are stored on a central server for use by all authorized persons. Administrative information such as attendance data, grades and reports card information, lunch counts, etc. can be more readily collected and compiled via a network, and library and other resources can be more readily accessed.

In addition to being an avenue for enhancing communications among persons, the Internet offers fantastic opportunities for gaining access to tremendous amounts of information. In fact, the Internet has been termed "a great worldwide library" where virtually any and every kind of information is available. Extensive databases can be reached from anywhere without regard to where the computer on which those resources reside is located. This characteristic makes networked computers excellent tools for engaging in high quality research.

Additionally, schools can create networks that enable them to engage in video conferencing. This, in turn, can lead to many new opportunities through distance learning, including opportunities for collaborative remote learning, joint research, and distance research.

7. Where can we get information which will help our planning team better understand networking?

Numerous "print" sources of networking information are currently available. These may be purchased in book format or are free on the WorldWide Web (WWW). Some of these sources present only information about the technical aspects of networking, while others deal primarily with how to use networks and networking issues such as staff training, network support and maintenance, security, etc. The following list contains excellent resources in both formats. Most of those listed provide information dealing with several aspects of networking.

Computer Networking for Educators, Ted D.E. McCain & Mark Ekelund, International Society for Technology in Education (ISTE), Second Edition, 1996 (ISBN 1-56484-107-3). *(May be purchased directly from ISTE. A membership discount applies. Contact: ISTE, Customer Service Office, 480 Charnelton St., Eugene, OR 97401-2626. Phone: 800/336-5191. FAX: 541/302-3778.)*

K-12 Network Planning Guide, K-12 Network Planning Unit, California Department of Education, PO Box 944272, Sacramento, CA 94244-2720, Phone: 916/445-1260 (ISBN 0-8011-1166-8) *(May be purchased in print format at the address above. Also available via WWW at* <http://goldmine.cde.ca.gov/ftpbranch/retdiv/technology/K-12/NTPG/NTPG.html>)

Available via WWW:

A Guide to Networking a K-12 School District
<http://choices.cs.uiuc.edu/schools/lamont/thesis/toc.doc.html>

The Future of Networking Technologies for Learning
<http://inet.ed.gov/Technology/Futures/index.html>

Network Administrator's Survival Handbook
<http://tampico.cso.uiuc.edu/nas/nash/nash.html>

Internet Engineering Task Force Homepage
<http://www.ietf.org/>

The Ethernet Page
<http://www.ots.utexas.edu/ethernet/>

About ISDN
http://alumni.caltech.edu/~dank/isdn/isdn_ai.html

About ATM
<http://www.atmforum.com/atmforum/atm_basics/notes1.html>

8. What type of professional help will we need when designing our networks? Where can we find this assistance?

Networking a school can be a very imposing and complex task. Often schools do not have the necessary expertise and must look for outside help. Especially important is finding a professional individual to help with network planning and design. The services of good network engineer or systems designer are not inexpensive, but such services can save money in the long run by helping to avoid costly mistakes.

The important thing to remember is that network design should respond to educational needs. Therefore. it is important that school personnel have some knowledge about what networks are capable of and how they may be used effectively to enhance the educational programs. With this information, schools can participate more effectively with the professional network designer and create a network infrastructure that responds to educational needs rather than having to fit educational applications to a network structure that may not be capable of accomplishing desired goals.

Other types of help often needed by schools may include assistance with funding, labor, or knowledge and expertise. Sources of such help may be found locally, statewide, nationally, or online.

Local assistance:
Students and their parents are a valuable resource. Parents often possess expertise and knowledge needed by the school and are more than willing to share their skills if asked. Students and parents can also be helpful in conducting fundraising activities and providing labor for networking projects. Local businesses are also excellent resources, often providing skilled individuals from their staffs, equipment, services, and funds in return for recognition and publicity.

State and National assistance:
Governmental agencies, including legislative bodies and governors' offices are working to help schools get networked. Contact your state legislators and your governor's office to learn what efforts they have underway and offer your support to those efforts. If you find that they are not currently involved in such efforts, make them aware of the importance of instituting networking efforts on behalf of the schools and for the sake of the state's overall economy.

Also, become aware of funding opportunities that are available from national agencies such as the National Science Foundation (NSF), The Commerce Department's National Telecommunication Infrastructure Administration (NTIA) and others. Seek out those opportunities that best suit your local needs and participate in efforts to secure such funding.

Online:
The WorldWide Web is a rich source of information that can be helpful to a school's networking efforts. In addition to sources such as those mentioned above, contact can be made with other school districts to learn how they have been successful in their networking efforts. A wide range of information helpful in understanding educational networking issues is readily available online.

9. What resources will be required to manage our networks? What issues will come up and require resolution? Can we avoid them? How?

As with building the physical network infrastructure, there are many issues that must be addressed when implementing a school network. Most of these cannot and should not be avoided. Instead. it is best to know what the issues are and to plan intelligently for dealing with them. The first step is to DO YOUR HOMEWORK. Learn as much as possible about networking issues and how others have resolved them then use this information in planning to meet your school's specific needs.

Here is a rough laundry list of issues about which you should be aware and for which you should plan:

Acceptable Use Policy (AUP)
Each school district should have an AUP in place which deals with such things as who can use what network resources, for what purposes the network may be used, and under what circumstances network resources may be used. There are many examples of AUPs and information about AUP development available on the Internet. Here are a few--

Developing a School or District "Acceptable Use Policy" for Student and Staff Access to the Internet, Wolf, Clancy J., Ed.D., Educational Technology Coordinator, Olympic Educational Service, Bremerton, WA. *(This document provides an excellent discussion of issues that should be addressed by an AUP. It also contains some sample AUPs and an "exemplary" model recommended by the author).*
<http://www.gsn.org/web/issues/aup/policies.txt>

K-12 Acceptable Use Policies
<http://www.erehwon.com/k12aup/>

Chico State Gopher site *(Contains links to many AUP related sites. including AUPs for higher ed., K-12, Libraries, and other networks.)*
<gopher://chico.rice.edu:1170/11/More/Acceptable>

Staff Development:
The most frequently cited reason for networks being improperly utilized or under utilization is the lack of sufficient and appropriate staff training. Be sure adequate staff development is an integral part of your networking plan. Seek help from appropriate groups and agencies to help with planning in this area. Listed below are a couple of Internet sites that will help you plan effective staff development:

Key Elements to Successful Staff Development
<http://www.u.arizona.edu/ic/imp.tech/sd.key.issues.html>

Staff Development: Questions for Discussion
<http://copernicus.bbn.com/testbed2/desks/staffdev/allquestions.html>

Network Management/maintenance:
Network plans must include how the network is going to be managed and maintained. Who adds and deletes accounts? Who is responsible for adding, deleting, and maintaining network materials and resources? Who will maintain the equipment? These and many other questions must be answered. These are important and often time consuming functions. It is necessary to have specific individuals assigned to these tasks, and those assigned must have adequate time to attend the tasks. It is generally not wise or reasonable to expect a teacher or other staff person to complete this work "in their spare-time." Therefore, be sure to allocate sufficient human and fiscal resources to support management and maintenance activities. The following FAQ (Frequently Asked Questions) document can be found on the Internet at the indicated address. This document discusses a broad range of issues surrounding K-12 use of Internet in addition to other network management issues.

Frequently Asked Questions for Schools
<http://ds.internic.net/rfc/rfc1941.txt>

10. Our goal is to design an affordable network(s) that isn't obsolete by the time it is installed. What else do we need to know and do upfront?

The rapidity of technological change makes it difficult to predict the expected life span of any technology based system. Perhaps the best way to avoid early obsolescence is to adhere as closely as possible to broadly recommended technical standards. Such recommended standards often exist because they provide good current performance and upgrade paths that offer greater network longevity.

Examples of such recommendations would currently include:
1. Install Category 5 wiring (offers a good combination of cost effectiveness and provides strong upgrade path)

2. Use ethernet network protocols (also provides upgrade path from current 10 Mbps to 100 Mbps and possibly beyond)
3. Be sure your network is fully TCP/IP compatible (allows communication across the Internet).

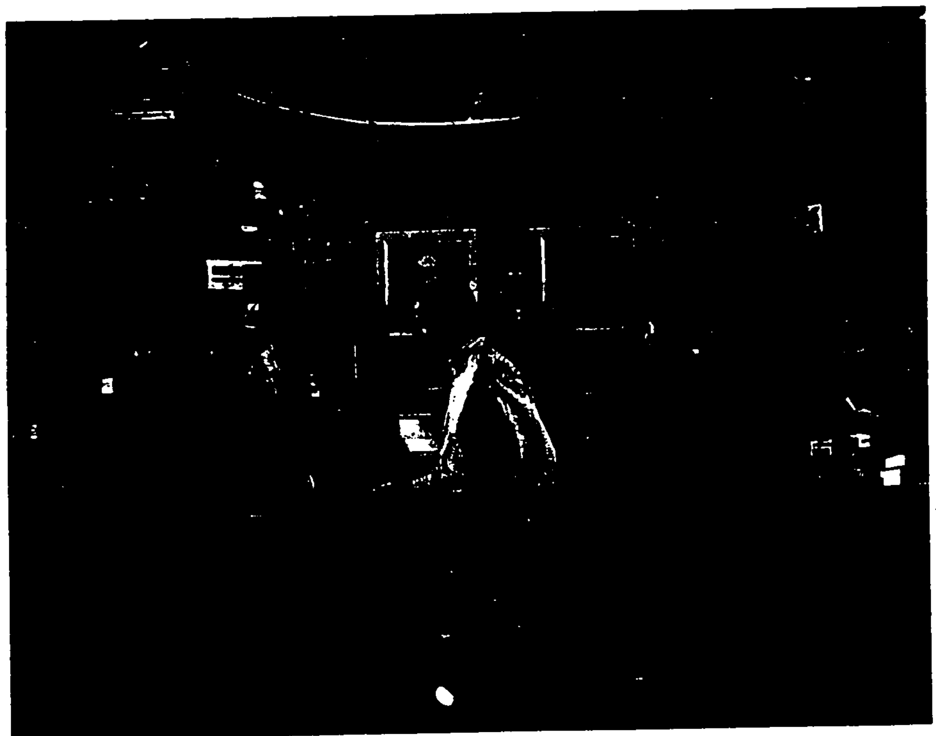
Here again, "doing your homework," seeking the advice of a knowledgeable network advisor, and sound planning will pay good dividends.

Some of the information sources listed under question # 7 above will give more recommendations. Also see the Internet Engineering Task Force's (IETF) recommendations in the following document:
K-12 Internet Working Guidelines
<http://ds.internic.net/rfc/rfc1709.txt>

Shopping for
Technology

With advanced planning and consumer research, school districts can buy hardware and software that fit their budgets and—most important—their math and science goals.

James A. Middleton, Alfinio Flores, and Jonathan Knaupp



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Well, we just passed the computer bond issue, so we have the money. Now what are we going to do with it? Educators often ask this question when their districts begin to infuse technologies into their mathematics and science programs. While most such projects are not bereft of planning, the financial issues often outweigh curriculum, management, and teaching issues—the very opposite of what should occur.

Here at Arizona State University's College of Education, we work with middle school science and mathematics departments in the Phoenix area, providing them staff development, content, and technical assistance. We also place our students in local schools for their field experiences and student teaching.

Over the past several years, a number of local districts have begun to buy computers or upgrade their current equipment. Many have complained of the futility of attempting to select equipment that will be useful and won't quickly go out of date. The three most common frustrations, in our experience, are the following:

1. We Bought Them, but Nobody Uses Them

This is one of the most frustrating situations a district can face. Technologies are not used for a number of reasons, but all boil down to two basic problems: They don't do what we want or we don't know what to do.

They don't do what we want. Very often the lion's share of money allocated for technologies goes for hardware: computers, monitors, keyboards, and peripherals. Educators ordinarily do little advance planning to determine what software is needed for teachers and students to use computers effectively in the classroom. In science and mathematics, in particular, most published software is really pretty bad. A district must look carefully to determine whether the software is any good and where it might fit into curriculum goals (see Flores, et al. 1997, for a list of software we find exemplary).

Additionally, most good software requires more memory than basic computer models have. This is often an unanticipated or underestimated expense that can seriously deplete funds originally earmarked for software. Therefore, you must account for software and memory requirements at the start of the planning phase, not at the

end. After deciding what software you will need to meet your curriculum goals, determine the *optimal* memory requirements and build these into your purchase plan.

We don't know what to do. Many teachers face the added frustration of not understanding the peculiarities of the software, how the computer works, or how to alter their teaching styles to accommodate the new tool. Here, staff development is a key issue, but again, most districts do not factor this into the financial package for technology infusion. As a result, staff members do not fully use available technologies. A teacher we work with recently switched from a DOS/Windows environment to the Macintosh platform. Even when using software he was familiar with on his old machine, he was maddened by the new quirks and nuances of the Macintosh version.

Even more challenging are teachers who have never used computers. They may resist implementing technologies in their classroom because they are (1) uninformed about how computers can improve their teaching; (2) too short of time to begin the difficult process of learning to use computers in their classroom; or (3) afraid of computers because of past experiences, colleagues' horror stories, or changes they anticipate.

2. Too Many Kids, Too Few Machines

The most common strategy for reducing the ratio of students to computers is to create computer laboratories. Although this strategy allows students to have blocks of hands-on time with computers, we believe it creates more problems than it solves. First, it is hard to schedule activities in computer labs (some teachers find it so difficult that they simply give up). Competition for time slots in the laboratory can be intense. The likely result is that no students have consistent or long-term experience with computers in any one subject area.

A second problem is that real scientific activities and hands-on mathematics are difficult to carry out in a computer laboratory. Most such activities require more room and equipment than staff members can haul into and out of a room not dedicated to such activities. Many of the best uses of technologies for mathematics and science involve probeware—devices that take information from the environment (the velocity of a falling object, for example) and enter that information directly into a data file (see Middleton et al. 1996 for examples of these technologies).

A single high-end machine with a projection device can involve an entire classroom of children in solving a math problem or understanding a scientific concept.

A third, more important problem is that when large numbers of computers are in a room separate from classrooms, many students get hands-on experience occasionally, but no one gets to use the computer in a truly *authentic* way—that is, the way a scientist or mathematician might use it to solve a difficult, time-consuming problem. In order to be true tools for learning, computers must be on hand when the need arises, not next week when the lab is open.

3. Obsolete? We Just Bought Them!

People purchase technological products only to find them outmoded in the blink of an eye—a problem for which the computer industry itself bears some responsibility. By all indications, this problem is bound to get worse, not better. After purchasing $50,000 worth of equipment on the Power Macintosh platform, for example, we were shocked to learn that IBM—one of the companies collaborating on the Power PC chip—would no longer adapt its operating system to support the platform. So where does that leave us? Will Apple continue to use the Power PC? Will we still be able to get software? What about servicing? These are issues that the fickle nature of the industry leaves us to grapple with.

But there is another reason that machines so quickly become obsolete for educational purposes: In an attempt to give the maximum number of students exposure to computers, school districts typically purchase a large number of low-quality machines. In three years' time, the district must replace them. A better approach is to buy fewer high-end machines that will do what you want, last longer, and be organized so as to maximize student "minds-on" time. (See page 22 for a list of principles for determining whether technologies are being used in an authentic and effective way.)

Better Ideas

Here are some suggestions for avoiding the above problems when choosing, purchasing, and using technology.

Eliminate one-student, one-machine thinking. The fallacy that has most inhibited effective use of computing technologies in K-12 education is the belief that each child must have his or her own computer for any given activity. This is just not so. Pairs, trios, and even larger groups of students can use a computer effectively if the staff develops the activity properly.

In fact, we encourage districts to *maximize* the number of students who share a machine. Although this seems counterintuitive, it is an effective way to authentically integrate computers

into the mathematics and science curriculum. A single high-end machine with a projection device can involve an entire classroom of children in solving a math problem or understanding a scientific concept. As each student tries out hypotheses and modifies them, all students can share in the public record of thinking. Only when all classrooms have this capability should educators start thinking about buying more machines.

Build technology into the curriculum. Otherwise, technology will only be tacked on. For example, demonstrating the trigonometric ratios using

> *A district must look carefully to determine whether the software is any good and where it might fit into curriculum goals.*

The Geometer's Sketchpad (Jackiw 1995) is not as effective as using the software to explore, model, and subsequently verify the functions. To build in technology this seamlessly, most districts will have to revise most of their standards, as well as their texts and other materials.

Some aspects of science and mathematics cannot be taught meaningfully without using computing technologies. For example, by middle school, the field of statistics in some published curriculums becomes so dependent on complex data sets that even students using scientific calculators have difficulty understanding the underlying patterns among the data. In science, students using computer-based probeware can find empirical data for what were formerly abstract, theoretical concepts. Such probeware also helps students develop both mathematical and scientific concepts at the same time, making the applications even more cost-effective.

Make the technologies available at all times. Students and teachers need consistency for the educational process to run smoothly. For technologies to be among the many tools a teacher employs to help the class grasp difficult mathematical or scientific concepts, they must be on hand when needed—just as pencils and paper must be on hand for students to take notes. Without the ability to take notes during a discussion of a complex topic, students cannot record the connections they make and gain insights into how the concepts fit together in a higher-order fashion. In a mathematics class, the teacher might ask whether a falling object does indeed have a parabolic position/time curve. Ideally, the teacher should feel free to ask students how they would go about finding the answer and then engage students in this type of proof using the available technology. Having students do this a week later in a computer lab is no substitute for such immediate follow-up in the classroom.

Make sure your computers can talk to one another. Even if your district can only afford a single machine for each classroom, the computers must be able to share resources (tools, models, and representations) so that students can share resources as well. A scientific or mathematical concept is useful only if people can share it, take it apart, and discuss its logical structure and ability to explain and predict phenomena. This gets at the very nature of scientific and mathematical verification (National Research Council 1996; National Council of Teachers of Mathematics 1989).

It is crucial that students be able to modify hypotheses, as most models students construct in the beginning will be either incomplete or contain misconceptions. Over time, the teacher and students can pare down the initial ideas into a workable model that can serve the class as a whole.

Further, when computers—even those separated by classroom walls—are linked, the teacher can pool them for a particular activity, thereby reducing the student-computer ratio significantly.

Build physical plant considerations into your purchase plan. One of the big surprises districts often face when purchasing computer equipment is that their buildings have inadequate electrical, communications, security, and space requirements. Correcting these shortcomings is expensive—often more

Seven Principles for Using Technologies to Teach Science and Math

1. Technologies are instruments that educators should use judiciously at the proper time in the proper place. They neither supplant the thought processes of children nor make learning fun or easy.
2. Technologies should enable students to do what they couldn't do without them (for example, engage in scientific experiences not feasible with other tools).
3. Technologies must be on hand all the time so that when the need arises, students can integrate them into their learning.
4. Technologies should allow students to develop, refine, and test mathematical and scientific phenomena. Thus they should facilitate the creation of information that students can share, modify, and transport elsewhere.
5. Technological systems should be user-friendly, making it easy for students to share data and resources.
6. The setup of computers and classroom space should increase communication among students, not stifle it.
7. Technologies must engage students in independent exploration.

Adapted from a report submitted to the National Science Foundation (Flores et al. 1997).

expensive than the technologies and software themselves.

These kinds of physical improvements require more long-range planning than does the immediate technology plan. You must envision the technological future of the school, as well as what telecommunication companies have in store—and build on both types of information. Consult with your local telecommunications companies to ascertain their long-range plans so that you will be prepared for the changes to come.

By following all these suggestions, your technology purchases should support your academic goals in practical ways, improve teaching and learning, and make the most of the money you have. ■

Although a computer laboratory allows students to have blocks of hands-on time with computers, we believe it creates more problems than it solves.

References

Flores, A., J.A. Middleton, J.E. Knaupp, and F. Staley. (1997). *Authentic Integration of Technology in Science and Mathematics Teacher Education*, a technical report submitted to the National Science Foundation. Tempe: Arizona State University.

Jackiw, N. (1995). The Geometer's Sketchpad 3. Berkeley, Calif.: Key Curriculum Press (software program).

Middleton, J.A., J.E. Knaupp, and F. Staley. (1996). "Using Data Probes for Integrated Mathematics and Science." An online article. Internet site: *http://sundial.ed.asu.edu/teams/Probes/Probes.html*.

National Council of Teachers of Mathematics. (1989). *Curriculum and Evaluation Standards for School Mathematics*. Reston, Va.: NCTM.

National Research Council. (1996). *National Science Education Standards*. Washington, D.C.: National Academy Press.

Authors note: Funding for the project report on which this article is based was provided by the National Science Foundation. The opinions expressed here are those of the authors and do not necessarily reflect the views of the National Science Foundation.

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STAGECAST TO BRING APPLE'S COCOA TECHNOLOGY TO MARKET

Startup Licenses Proven Authoring Technology for Kids

Palo Alto, Calif., October 13, 1997 -- Stagecast Software, Inc., a K-12 software company, announced today that it will develop commercial products based on Apple Computer Inc.'s Cocoa technology. Due to recent changes at Apple, the computer company discontinued commercial development of Cocoa. Members of the original Apple development team formed Stagecast to further their dream of creating a product line that takes advantage of the simple graphical programming technology first demonstrated in Cocoa.

David Smith and Allen Cypher, two of Stagecast's founders, were key Cocoa researchers and inventors while at Apple. "We designed Cocoa to be as much fun as a video game, but with challenges that develop thinking and communication skills," said Smith. "Our products will exercise kids' minds, not their thumbs." Cypher alluded to studies indicating that children are spending less time in front of the television and more working with computers. "Our goal is to develop products that replace watching time with thinking time," he said.

"A child having fun with Cocoa is exercising skills that will be useful in school, life, and career," said Larry Tesler, president of Stagecast and former chief scientist of Apple. "Stagecast will develop cross-platform products that strike a balance between the fun factor required by children and the skill development factor desired by parents and teachers."

Mike Lorion, vice president of education, Apple Computer, Inc., said, "Apple has demonstrated Cocoa research prototypes to many educators and the response was enthusiastic. By working with Stagecast to bring Cocoa technology to market we are delivering a great tool for educators and are confident that Stagecast will fully realize the great promise of this

technology."

Cocoa is an authoring tool and player for desktop and web-based children's software. Apple Computer currently distributes a research prototype of the software tool. Apple's latest design release of Cocoa for the MacOS, version DR2, has been available as a free, unsupported prototype from Apple's web site since July 1997. Version DR2 is now available for free download from Stagecast's web site at http://www.stagecast.com and from Apple's web site http://cocoa.apple.com.

Stagecast Software, Inc., headquartered in Palo Alto, California, develops and markets software for K-12 learning activities.

To arrange interviews or for more information, contact Marsha Keeffer or Bruce Roseman at Brough Communications by phone or e-mail.

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Karl May, Stagecast Software, Inc., Tel: (650) 614-9111 ext 3, Fax: (650) 614-9119, Email: kmay@stagecast.com

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Stagecast Software, Inc.

Developer of communications technologies that enable individuals to have control in creating and maintaining communications relationships over the Web and other electronic networks.

Lanacom
Developer of Headliner, which delivers news and information to Windows 95 and NT desktops.

Marimba
Applications technology company whose products enable developers to create, deploy and maintain robust network managed applications, multimedia experiences, and dynamic information systems within enterprises and across the Internet.

Mercury Mail
Information gathers/customizers who send this requested information to their customers for free.

NetDelivery
Free customizable information service provider.

PointCast
Free, advertiser-supported, customizable news network that broadcasts national and international news, stock information, industry updates, weather, and sports scores.

RevNet
Offers a software program for management and delivery of information over the internet.

Tierra Communications
Offers an information gathering software tool.

Verity, Inc.
Develops and markets software tools and applications for searching, retrieving, and filtering information across the Internet, enterprise and CD-ROMs.

Wayfarer
Developer of Incisa, an intranet Webcasting solution for business that allows managers to push relevant business information to employee desktops.

Streaming Media Technology Providers

Intel Intercast
Intercast Technology, developed by Intel and Intercast, allows users to receive HTML-formatted Web pages and streaming information along with regular televised programming using the Vertical Blanking Interval (VBI) signal.

Inter VU
A video/multimedia delivery service that delivers a quality video experience through your Web site. The result is faster video that keeps viewers tuned to your site. InterVU works with all popular platforms and all video formats for on-demand video delivery.

Microsoft Netshow
Creator of Enliven software, which streams Macromedia Director files over the Web to viewers using the free viewer plug-in for Netscape Navigator.

Motorola
Developer of TrueStream, which delivers compressed, high-quality audio and video over low bandwidth Internet connections.

Narrative Communications
Creator of Enliven software, which streams Macromedia Director files over the Web to viewers using the free viewer plug-in for Netscape Navigator.

Progressive Networks
Creator of RealAudio, RealVideo, and RealVideo software, which allows user to recieve live and archived audio and video broadcasts in real time.

Macromedia
Creator of Shockwave animation format for the Web and the new Shockwave player, which delivers streaming animation, audio, and multimedia to you with little or no waiting.

Vosaic
Developer of the Java-based Sound Applet and VDP Video Plug-in for streaming audio and video into Java-enhanced browsers.

Learning Through Collaborative Visualization (CoVis)

Traditionally, K-12 science education has consisted of the teaching of well-established facts. This approach bears little or no resemblance to the question-centered, collaborative practice of real scientists. Through the use of advanced technologies, the CoVis Project is attempting to transform science learning to better resemble the authentic practice of science.

The CoVis Project is comprised of a team of collaborating researchers in the Learning Sciences at Northwestern University in Chicago, the Department of Atmospheric Sciences at the University of Illinois in Urbana-Champaign, the Exploratorium in San Francisco, and Bellcore in New Jersey.

The CoVis Project will explore issues of scaling, diversity, and sustainability as they relate to the use of networking technologies to enable high school students to work in collaboration with remote students, teachers, and scientists. An important outcome of this work will be the construction of distributed electronic communities dedicated to science learning.

Participating students study atmospheric and environmental sciences through inquiry-based activities. Using state of the art scientific visualization software, specially modified to be appropriate to a learning environment, students have access to the same research tools and data sets used by leading-edge scientists in the field.

The CoVis Project provides students with a range of collaboration and communication tools. These include: desktop video teleconferencing; shared software environments for remote, real-time collaboration; access to the resources of the Internet; a multimedia scientist's "notebook"; and scientific visualization software. In addition to deploying new technology, we work closely with teachers at participating schools to develop new curricula and new pedagogical approaches that take advantage of project-enhanced science learning. "Collaborative Visualization" thus refers to development of scientific understanding which is mediated by scientific visualization tools in a collaborative context. The CoVis Project seeks to understand how science education could take broad advantage of these capabilities, providing motivating experiences for students and teachers with contemporary science tools and topics.

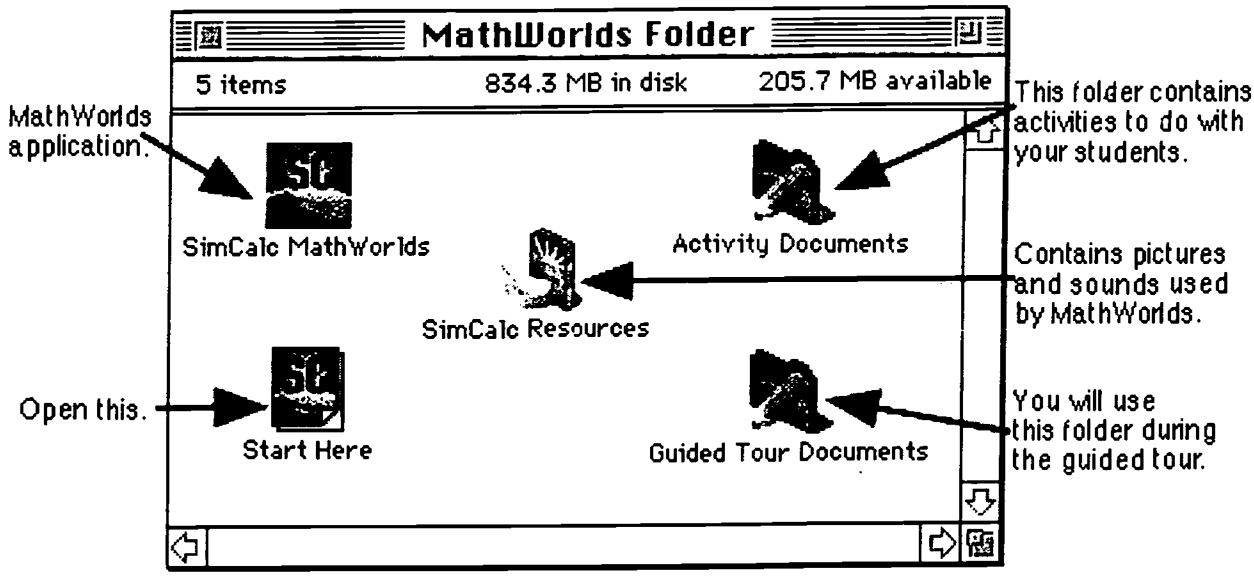
The next decade will bring widespread, networked multimedia interpersonal computing. The CoVis Project is a blueprint to inform educators, researchers, and policy makers on the effective and sustainable use of interpersonal, collaborative media in science education.

Click here to read a summary of the CoVis NIE Proposal

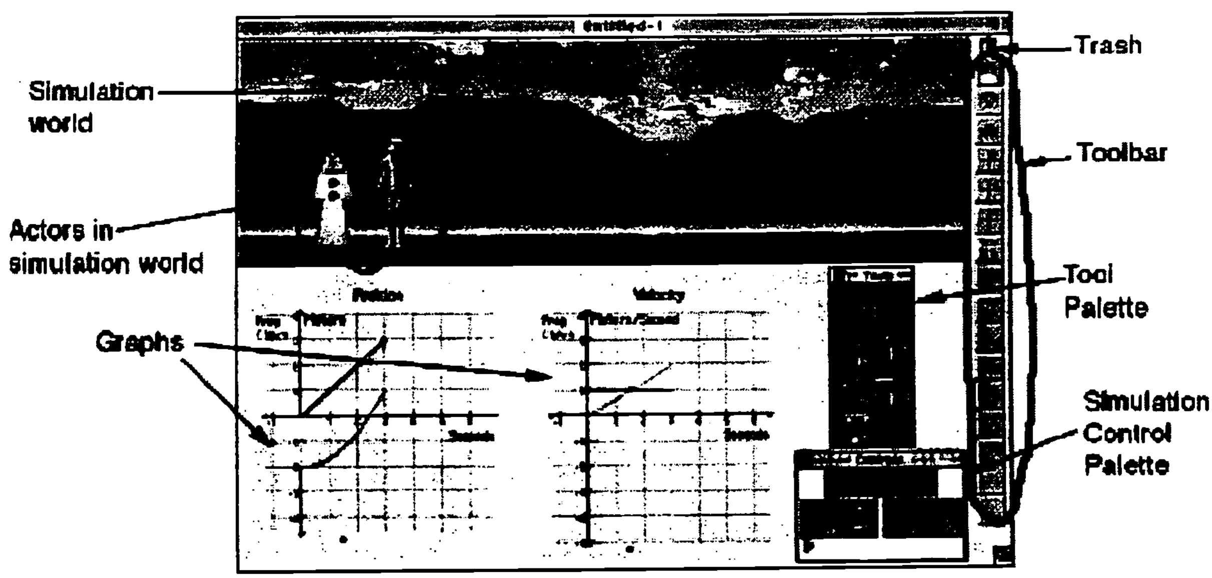
A Two-Page Overview Document of the CoVis Project is available (this is a postscript document - click here for a utility to print postscript from Macintosh computers).

WHAT IS COVIS? | GEOSCIENCES HOME | COVIS WELCOME PAGE

1. Open the MathWorlds folder. You should see this:



2. Open the icon labelled "Start Here." After a short delay you should see the window pictured below. Take a moment now to read the labels in the picture, and identify the items on the screen.



Note: MathWorlds works best if you monitor is set to 256 colors. If the monitor is not set to 256 colors, MathWorlds will adjust it for you. When you quit MathWorlds, the original monitor settings will be restored.

What To Do Next

To learn how to use MathWorlds, you should now turn the page and continue on to the Guided Tour. If you prefer to explore on your own, please see the Quick Reference Card. After you complete the Guided Tour or your own explorations, you may try the Learning Activities in the Activity Documents folder.

Guided Tour 1

This guided tour begins a series of practice activities that will help you learn to use MathWorlds. These

activities are similar to the activities you will use in your classroom, but include extensive step-by-step instructions. You should already be familiar with the Macintosh interface before beginning this tour.

Goal

In this first guided tour, your goal is to find three different ways to get an elevator to rise to the sixth floor. Notice what remains the same in each of the three motions, and what is different.

Continue with Guided Tour 1

Guided Tour 2

In this tour, you will learn to manipulate piecewise linear functions, and will explore position graphs as well as velocity graphs. In MathWorlds, piecewise linear functions are the fundamental building block for exploring mathematics of change concepts. Although this activity only uses position and velocity graphs, the skills you learn also apply to the four other graph types: acceleration, absolute value of acceleration, speed (absolute value of velocity) and distance graphs.

Goal

In this activity you will create graphs (and motions) that match stories written in English.

Continue with Guided Tour 2

Guided Tour 3

In this tour, you will learn several features that allow you to control MathWorlds' simulation and graphs more precisely, including stepping, scaling and zooming graphs, and editing graphs that contain multiple plots.

Goal

MathWorlds can be used to solve many classic "math story problems" with more graphical insight than is possible with algebra alone. In this tour, you will solve this problem:

An actor named "Dude" begins walking to the right at 2 meters per second. The other actor, "Clown", begins 15 meters away and walks to the left at 1 meter per second. Where do they meet? At what time do they meet?

Continue with Guided Tour 3

Guided Tour 4

By now, you have learned most of the important features in MathWorlds. In this last Guided Tour, you will learn a few additional features that will help you explore new activity documents.

Goal

In this activity, you will construct a velocity graph to match a given position graph.

Continue with Guided Tour 4

SimCalc

MathWorlds QuickStart Reference Guide

Introduction

Purpose

The SimCalc Project's mission is to enable all students to develop full understanding and practical skill with the Mathematics of Change and Variation - including fundamental concepts of calculus - in meaningful contexts, through a combination of advanced technology and curriculum reform.

This MathWorlds software enables students to learn the mathematics of motion through exploration of animated worlds and dynamic graphs. The worlds present actors in a variety of settings, like an elevator building or a duck pond. Graphs control the motion of these actors and their interaction with their simulated environment. By solving challenges with these actors and graphs, students encounter and master calculus concepts including the meanings of position, velocity, and acceleration graphs; the relationships between slope nd rate, and area and accumulation; and the mean value theorem.

Instructional Level

The SimCalc team tested MathWorlds extensively with pre-algebra middle school students and pre-calculus high school students. In addition, with teacher adaptations, we have found that students can use MathWorlds in elementary school. University professors have also used MathWorlds in introductory calculus and physics classes, to help students conceptualize position, velocity and acceleration.

NCTM Standards and Mathematical Ideas

Teachers can use MathWorlds to address these broad NCTM standards:

- Mathematics as Problem Solving
- Mathematics as Communication
- Mathematics as Reasoning
- Mathematical Connections
- Measurement
- Computation and Estimation

More specifically, our research shows that MathWorlds helps students develop their understanding of the differences between "how fast" and "how much" (rate and accumulation), and many other important mathematical concepts, including graphing, positive and negative numbers, area computations, graphical intersections, algebra story problems, and calculus theorems.

Installing and Starting MathWorlds

What you need

To use MathWorlds, you will need:
a Macintosh PowerMac , Quadra or 040-based Performa
at least 10 MB free on your hard drive
at least 12 MB of RAM
a color monitor
System 7.5 or greater

Note: You may use MathWorlds with System 7.0 or 7.1 if you install three files, (1) AppleEvent Manager, (2) AppleScript, and (3) Macintosh Drag and Drop, in the Extensions folder of your System Folder.

You will need two pieces of software to complete this installation. If you do not have them, they are available from sources listed below.

- **Stuffit Expander** (Available from Aladdin's website and also download.com.)
- **Apple's Disk Copy (6.1.2 or greater)** (Available from Apple's software updates page or from download.com)

Also, it is best to remove old version of MathWorlds from the machine. This helps avoid confusion and bugs. MathWorlds does not install any extensions or other files outside of the MathWorlds folder, so removing your old MathWorlds folder should be sufficient to remove the old installation from your hard drive.)If you have the capability and desire, by all means back up your old MathWorlds folder before removing it from your hard drive and installing the new software.

Installing MathWorlds from the Web

First, download the MathWorlds 1.1 installation from the SimCalc Website.

It's in BinHex format, (.hqx) so you use StuffIt Expander to un-BInHex and Un-Stuff the archive. When this is complete, you should now have a folder called "SCMW Installation Disks" containing two floppy disk images.

To install from these disk images, drag and drop the floppy disk images on to Disk Copy 6.1.2 or greater (see above for how to get Disk Copy). They should then be mounted, and will appear to be floppies on your desktop. Double-click the self extracting archive on disk 1 and follow the instructions to install MathWorlds.

You're done!

If you would like to make real floppies (which come in handy for installing MathWorlds on machines that do not have a network connection) you must have 2 blank High Density floppies available.

Launch Disk Copy and choose "Make A Floppy" under the utilities menu. Disk Copy will prompt you to locate the disk image you want to turn into a floppy. Follow the instructions repeat for both disk images and you should then have two fully functional MathWorlds installation disks.

Installing MathWorlds from Floppy Disks

To install from the floppies, simply put install disk 1 into the Mac and launch the self-extracting archive. Thge self-extractor will allow you to choose a folder to install into and prompt you when the second disk is needed.

When the self-extractor finishes, you're done!

Getting Started

Get More Info | Order Now!

Click the above buttons to **Get More Information** or to
Send an Order to one of **ADI's Authorized Academic Resellers!**

12180-1 E.Turquoise Circle
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Fax: 520-772-8855
E-mail: sales@academic-wholesale.com
Webmaster: MHannigan1@aol.com

instructional advice

- Includes an on-line instructional design course
- Twelve wizards help with tasks such as creating properly formatted reports, writing 5-part objectives, and specifying course structure
- A comprehensive library of instructional strategies (with 500 matching templates)

Open Architecture:

- Supports any RTF compatible word processor
- Authoring system independent
- Interface easily customized to designer's own phases and tasks
- Easily attach other development software (ie software for video editing, media selection, graphics, etc)
- Add custom templates, motifs, data collection forms, and instructional strategies
- Connectivity to database through ODBC output

Designer's Edge™ is a native 32 bit application that exploits the power of the Windows 95 platform.

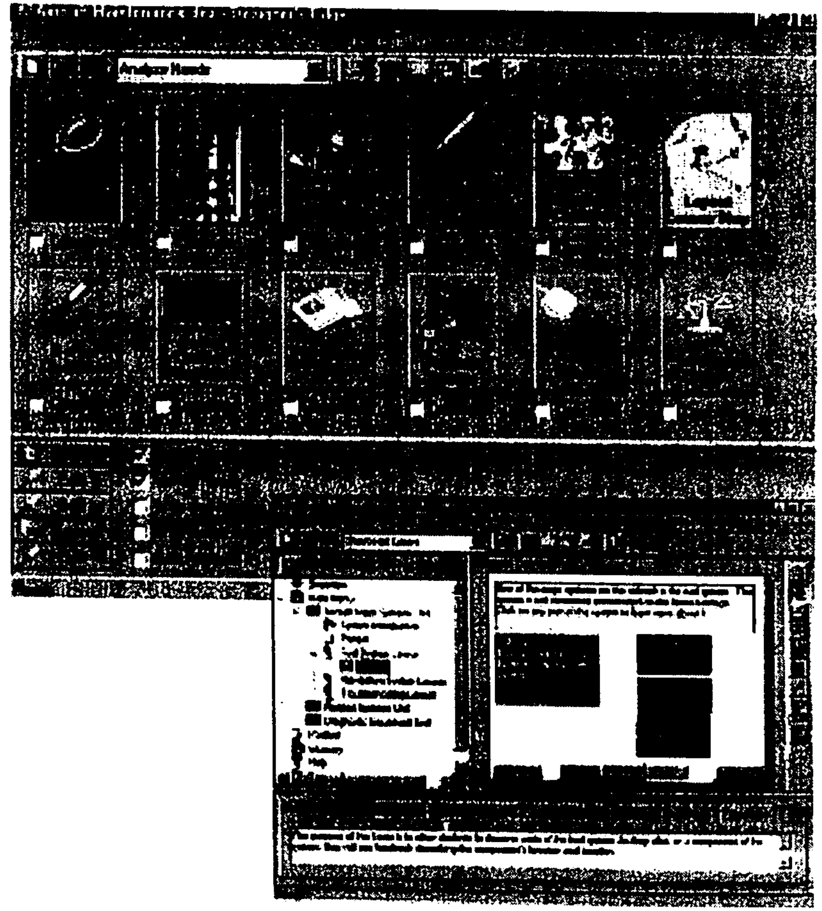
Designer's Edge is produced by Allen Communication, a Times Mirror Company. They can be contacted on the Web at http://www.allencomm.com/

Designer's Edge™

Introducing the first integrated pre-authoring tool for instructional designers

Designer's Edge is a set of integrated pre-authoring tools and wizards, built by instructional experts to accelerate the analysis, design, and evaluation of effective technology-based training.

Designers Edge offers a visual, task-driven interface that walks users through the entire instructional design process from analysis to evaluation. It enhances productivity dramatically for both experienced and novice designers by providing dynamic tools for process acceleration and data organisation, unprecedented on-line instructional expertise, and powerful extensibility features.



A Performance Support System for Instructional Designers

Process Acceleration:

- Integrates data and displays it in a visual course map for easy access
- Shares data to maintain continuity between design phases and consistent development between projects
- Links hundreds of pre-built templates to specific instructional strategies

BEST COPY AVAILABLE

- Twenty-five pre-built data collection forms
- Wizards to prompt designers through the development of key reports and other materials
- Stores all design files for easy access by any member of the development team.

Data Organization:

- Automatically generates key documents, such as needs analysis, audience profiles, course maps, design strategies, script-storyboards, and more
- Organises all data into a visual course map for quick navigation between content, objectives, treatment, and strategies
- A fully integrated script-storyboard with visual screen layout capabilities
- Creates a central media log of video, graphics, audio, and animation elements, all with on-line sorting capability
- Enhances group productivity by making relevant data easily accessible to team members

On-line Instructional Expertise:

- Step by step guidance through the instructional design process (ISD model)
- On line, context sensitive

eyeQ

InterVU Multimedia Manager

Download Now! FREE

Macintosh Power PC - Netscape 2.0 - 4.01* Installation Instructions

*Vivo player incompatible with Netscape Communicator at this time.

Step 1: Download InterVU's EyeQ installer.
Step 2: Click the Installer Application twice to run it (not the .hqx or .sit files).
Step 3: The default installation asks you to select the Netscape Folder. This is the folder where the Netscape Application is located (Netscape's Parent Folder).
Step 4: The following Netscape Plug-Ins are installed by default into the Plug-Ins folder located in the Netscape folder.

- InterVU Network Smart Seek
- Vivo VivoActive player
- QuickTime Plug-in player
- InterVU MPEG player

The following are installed into the "start up disk" in the InterVU folder. An alias of the folder is placed on the desktop.

- InterVU Fast Track
- InterVU Help and Readme files

Step 5: The Custom install permits you to install individual Netscape plug-ins or the Fast Track and Help/Readme files.
Step 6: Installation trouble shooting suggestions are located inside the Plug-In Help/Readme files folder which is inside the InterVU folder. **Note:** The Mac Threads Manager extension is installed if it is not present.

Vivo Software
Creator VivoActive, a serverless streaming video product.

VXtreme
Developer of Web Theater software suite, anabling users to create and send real-time compressed video across the Internet and corporate intranets.

Xing
Developer of StreamWorks Player (for viewing live and on-demand real-time audio and video) and the XingMPEG Player.

Agent Companies

AgentSoft
Develops and markets sophisticated agent technology, agent development tools, and agent services and applications for the Internet and the corporate Intranet.

Broadvision
Offers software product that enables application developers and business managers to develop efficient Web sites with personalized content.

Firefly
An agent that recommends movies and music based on preferences that are input; also offers live chat rooms and personal home pages.

iCat
Offers iCat Electronic Commerce Suite to aid users in creating, managing, and delivering sophisticated Web catalogs.

Movie Critic
Recommends movies and videos (Best Bets) and gives probable ratings on titles that interest you based on movie ratings you provide.

Open Sesame!
Free service that informs user of upcoming movies, books, television programs and entertainment events that are of interest, based on information provided to Open Sesame's proprietary learning agent technology.

Web Advertising

Technique Conference

Web Broadcasting

Web Design '97

Wise Wire
Free service that uses advanced neural network agent technology to filter content to the subscriber.

If you would like to be informed by e-mail of new events and special offers, enter your e-mail address below. We won't sell this to anyone.

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Inspiration®

Education Edition

Use **Inspiration 5.0 Education Edition** to enhance learning in the classroom. This powerful visual learning tool inspires students to develop ideas and organize their thinking. Use Inspiration to dynamically create and modify concept maps, webs and other graphical organizers.

The integrated Outline view enables students to quickly prioritize and rearrange ideas, helping them create clear, concise writing.

Visual Toolbars

Visual toolbars make Inspiration easy to learn and use, providing an interface for accessing all major Inspiration functions.

Symbol Palette

Students can find just the right symbol shape to convey their ideas by quickly browsing through the libraries on the symbol palette.

Over 500 Symbols

Students easily personalize their diagrams using the 500+ symbol shapes provided in Inspiration. Inspiration 5.0 Education Edition has special libraries for students that include representations of holiday themes, seasons, animals, transporation, sports and more. Other graphics can be imported or pasted into Inspiration for easy use.

Integrated Diagram and Outline Views

Fully integrated Diagram and Outline views help students cross the breach between non-linear and linear organization. Switching between the views shows students how to convert their free-form thinking into a hierarchical structure. The sample diagram section has several examples of the diagram-outline switch.

Templates

Nearly a dozen new templates help students get started with concept mapping and webbing, and provide worksheets for teachers to use with the class. The templates can be used as static documents, but primarily exist to show teachers how to better integrate visual learning methodologies into the classroom.

Cross-platform Compatibility

Inspiration's cross-platform (Macintosh and Windows) compatibility serves computer labs and schools with a mix of platforms.

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